Environmental Security Technology Certification Program (ESTCP)

Final Report for ESTCP Project CU-200020

PIMS™: Remediation of Soil and Groundwater Contaminated With Metals

PIMS™ Remediation of Soil Contaminated with Lead at Camp Stanley Storage Activity, TX

Work Performed by
UFA Ventures, Inc. and
Los Alamos National Laboratory
for
Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015-4800

August 2003

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **AUG 2003**	2. REPORT TYPE	3. DATES COVERED **00-00-2003 to 00-00-2003**

4. TITLE AND SUBTITLE **PIMS: Remediation of Soil and Groundwater Contaminated With Metals PIMS Remediation of Soil Contaminated with Lead at Camp Stanley Storage Activity, TX**	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **UFA Ventures, Inc,7401 W Grandridge Blvd Ste 201,Kennewick,WA,99336**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**603**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

TABLE OF CONTENTS

APPENDICES:

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
μg/dL	Micrograms per deciliter
AFCEE	Air Force Center for Environmental Excellence
APPL	Agriculture & Priority Pollutants Laboratories, Inc.
ASTM	American Society for Testing and Materials
CDC	Center for Disease Control
CFR	Code of federal regulations
cm	Centimeter
CQAP	Construction Quality Assurance Plan
CSSA	Camp Stanley Storage Activity
DoD	Department of Defense
GAC	Granulated Activated Carbon
ESTCP	Environmental Security Technology Certification Program
FR	Federal Register
GFAA	Graphite Furnace Atomic Adsorption
HASP	Health and safety plan
HCL	Hydrochloric Acid
HWIR	Hazardous Waste Identification Rule
ICP/MS	Inductively Coupled Plasma/Mass Spectrometer
IMCA	Interim Measures Corrective Action
IWT	International Waste Technologies, Inc.
Ksp	Solubility product
Kd	Soil-water partition Coefficient
LANL	Los Alamos National Laboratory
MCL	Maximum contaminant level
MCS	Media Specific Concentration
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
ml	Milliliter
MSL	Mean sea level
NCP	National Contingency Plan

OB/OD	Open burn open detonation
O&M	Operations and Maintenance
OSHA	Occupational Safety and Health Administration
Parsons	Parsons, Inc.
Pb	Lead
PIMS	Phosphate-induced metal stabilization
PPE	Personal protective equipment
ppb	Parts per billion
ppm	Parts per million
PRB	Permeable reactive barrier
QA	Quality assurance
QA/QC	Quality assurance quality control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial investigation
RMRS	Rocky Mountain Remediation Services
RL	Reporting Limit
RRAD	Red River Army Depot
RRS1	Texas Risk Reduction Standard 1
SAP	Sampling and analysis plan
SB	Soil boring
SCS	Soil Conservation Service
SERDP	Strategic Environmental Research and Development Program
SPLP	Synthetic precipitation leaching procedure
SW	Solid waste
SWMU	Solid waste management unit
SVOC	Semivolatile Organic Compound
TAC	Texas Administrative Code
TCLP	Toxic characteristic leaching procedure
TCE	Trichloroethylene
TCEQ	Texas Commission on Environmental Quality
TPDES	Texas Pollutant Discharge Elimination System

TRRP	Texas Risk Reduction Program
UFAV	UFA Ventures, Inc.
USDA	United States Department of Agriculture
USEPA	U.S. Environmental Protection Agency
UXO	Unexploded ordnance
VOC	Volatile Organic Compound
yd^3	Cubic Yard

Preface-Acknowledgements

PIMS™ is a simple technology. It uses a waste product to treat waste by stabilizing heavy metals *in situ*. In the sense of biodynamics, and under the principles of recycle and reuse, PIMS exemplifies another step in the process of restoring and renewing the surface of our planet after the ravages of the Industrial Age. Now, the Information Age can help us easily and widely disseminate how to use this simple, but elegant, technology to solve some of our heavy metal environmental problems.

Fortunately, SERDP and ESTCP have believed in, and supported, the development of PIMS using Apatite II™, starting in 1993 with bench scale proof-of-principle research, and concluding in 2003 with the results of a full-scale-field demonstration that has become an Interim Measure Corrective Action. Our first acknowledgements and great appreciation go to these two organizations and all of the dedicated and visionary people that comprise them who have served as mentors and guides to us throughout this decade-long process.

This demonstration and field activity succeeded because of the whole-hearted support and commitment of Camp Stanley Storage Activity, particularly the Environmental Officer, Brian Murphy, and the Post Commander, Colonel Jason Shirley, as well as the site contractor Parsons, Inc., especially the Project Manager, Ken Rice, and the Field Team Leader, Kyle Caskey. There are other organizations and companies to whom we express our appreciation: Agriculture & Priority Pollutants Laboratories, Inc., BATU EnviroTek, Inc., Brice, Inc., Idaho State DEQ, MCL Inc., MSE-TA, Inc., Parsons, Inc., Slater (UK) Limited, TechnoRem, Inc., U.S. EPA.

There are many individuals to thank: Xiaobing Chen, Dale Counce, Joel Cowger, Paul Didzerekis, Carlos Garcia, Bryony Hanson, Paula Heller, Craig Jones, Rene Jones, Ann Mockler, Joe Mockler, Tim Moody, Jill Noel, Steve Rembish, Mike Ruby, and Margaret Snow.

We see in the near future refrigerated cargo ships bringing millions of tons of fish waste from factory fishing ships back to shore to process to be used in PIMS remedial activities instead of being dumped into the oceans. We also envision developing and teaching fish farmers how to compost their fish waste so the bones can be used locally anywhere in the world to sequester heavy metals from waters and soils. This will happen. Good dreams do come true.

Best fishes,

Judith and Jim

EXECUTIVE SUMMARY

Lead-contaminated soils are prevalent in the United States, particularly at Department of Defense sites that have small arms firing ranges, detonation sites or testing facilities. Estimates of lead-contaminated soil from range use in the United States are 100 million cubic yards, far exceeding that which can be disposed to landfills. Additionally, large quantities of lead-contaminated leachates generated by rainfall and irrigation at many military sites flow over surface soils and into lakes or stormwater drain systems, or supply contaminated recharge to shallow aquifers. It is very important to find cost-effective, simple-to- implement remediation technologies to mitigate problems caused by past use, while providing pollution prevention for future use of these firing ranges.

Lead is the principal contaminant from projectiles (bullets) used at small-arms firing ranges. As a result, assessment and cleanup focus on the lead in soils and other environmental media. Chemically, lead is stable and does not biodegrade. High levels of lead and lead compounds induce disease and toxicity, particularly in children and pregnant women (U.S. Environmental Protection Agency [USEPA], 1994). The Center for Disease Control repeated lowers human blood levels of concern, e.g., 40 micrograms per deciliter (μg/dL) in 1978, 25 μg/dL in 1990, and the current level of 10 μg/dL.

At the present time, a nationally recognized safe lead concentration in environmental media has not been developed. Lead is ubiquitous and can occur naturally in surface and shallow soils at concentrations ranging from 5 to 50 parts per million (ppm). Therefore, USEPA has focused predominantly on reducing the potential for sensitive populations to be exposed to anthropogenic (human-made) lead sources (industrial emissions, leaded gasoline, and paint) and environmental media contaminated with lead as a result of human activities (sites of mineral extraction, smelting operations, and firing ranges).

To address lead-contaminated media from human activities, several *ex situ* or *in situ* treatment methods have been used, or proposed, that involve extraction, removal, solidification, or stabilization/sequestration. The Phosphate-Induced Metal Stabilization (PIMS™) technology discussed in this report is an *in situ* stabilization or sequestration technology. Like PIMS, many stabilization technologies use an additive to the contaminated soil that immobilizes the metal or renders it non-toxic, but does not change the basic nature of the soil, e.g., the permeability or porosity. These technologies allow the soil to function in the future as a soil, to be left in place or disposed of as a non-hazardous material. Solidification technologies, such as grouting (cement solidification) or *in situ* vitrification, immobilize the metal by changing the basic nature of the soil, rendering it a non-soil, which may or may not fit the desired future uses for the site.

The performance objectives of this demonstration were to determine suitable emplacement methodologies for the *in situ* treatment of lead-contaminated soils so the soil poses no further health threat or environmental hazard, and to determine actual field implementation costs. Both performance objectives were met. A further objective was to actually treat all of the lead-contaminated soils at an ordnance treatment unit at the Camp

Stanley Storage Activity (CSSA) so the soil could be released back to the site in a manner consistent with regulatory approval and future site use plans. This objective also appears to have been fulfilled.

This demonstration served the following two purposes. 1) It provided validation of the efficacy of the technology in the field at full-scale operation by: a) demonstrating the use of PIMS with Apatite II for stabilizing/remediating particulate lead *in situ* and b) determining actual field implementation costs. 2) It transferred the technology to an end-user (CSSA), by: a) determining the degree of regulatory acceptance; b) remediating the lead-contaminated soil at SWMU B-20 at CSSA; c) providing the Post with an acceptable *in situ* alternative to off-site disposal, and d) reducing off-site disposal costs through treatment of soil to a lesser waste classification.

The contaminant at the CSSA is particulate lead in soil from ordnance and firing range activities. The soils had previously been excavated, sieved, and placed into six 500-750 cubic-yard (yd^3) piles. One 500 yd^3 pile was used for the Phase I pilot-scale test, and the remaining soils were used in the Phase II field-scale demonstration. CSSA has been the lead in this demonstration, and all activities were coordinated by them and their subcontractor, Parsons, Inc (Parsons).

The experimental design for the PIMS cleanup remediation demonstration included treatment of approximately 3,000 yd^3 of lead-contaminated soils within the SWMU B-20 area. The soils had approximately 5 percent by weight of Apatite II material added and were mixed in 10 yd^3 batches. The treated soils were spread over the one acre demonstration site at SWMU B-20 for observations of efficacy by collection of leachates from shallow lysimeter monitoring wells. The field emplacement process was accomplished at an application rate of approximately 500 yd^3 a day using a backhoe/front-end loader and a maintainer.

A summary of characterization and monitoring results of both the Phase I pilot scale demonstration and the Phase II full-scale demonstration are presented in this report. Characterization efforts indicated that the sieved unamended soil contained an average concentration of 1,157 mg/kg (ppm) of soil with an upper confidence limit calculated at 1,720.5 mg/kg. Waste classification results from batch TCLP studies indicate that the PIMS-treated soils meet State of Texas class 2 non-hazardous waste classification criteria of 1.5 mg/L (per 30 TAC chapter 335 subchapter R) with an average concentration of 0.46 mg/L. The unamended soils did not meet these criteria. Average leachate monitoring results from the demonstration site are 6.5 µg/L (ppb) well below the 15 µg/L standard for lead in drinking water. Determination of risk associated with the site was accomplished using bioaccessibility data generated from *in vitro* analyses conducted by Exponent, Inc. on amended and unamended soils. Data from the bioaccessibility study were used to calculate preliminary remediation goals (PRG) using the United States Environmental Protection Agency adult lead model. PRG's calculated for the Apatite II-amended soil from the demonstration site raise the acceptable levels of lead to over 2,300

mg/kg. Therefore, CSSA has achieved acceptable levels of lead at the SWMU B-20 demonstration site by the amendment of soils with the PIMS treatment technology.

This demonstration was a full-scale remediation of SWMU B-20. No scale up is needed for any aspect. All costs are actual, not projected. The Apatite II material and delivery costs provide the best basis for projecting costs of implementing this technology. The process chemicals (the Apatite II material) and the shipping charges, represent 50% of the expended costs for the field-scale demonstration. This results from the ease of application of the Apatite II material. Process equipment consisted of a front-end loader and a maintainer which were used to move and mix materials. Labor consisted of a construction supervisor, two heavy equipment operators and an independent observer/health and safety site monitor. Fixed costs include start-up costs (planning, site characterization, mobilization, and site preparation costs) and operating costs such as process chemical and raw material purchases (Apatite II material, soil cover and vegetation). Operational costs include equipment rental, labor, and personal protective equipment (PPE). These costs account for nearly all of the costs of implementing this technology. Re-occurring costs such as performance testing are included; however, these costs represent a small fraction of the cost and may not be required for long-term monitoring if regulatory closure is obtained. The calculated costs for the field scale demonstration are less than \$25/yd^3 which includes a variable cost of \$15/yd^3. The variable costs are associated with the cost of Apatite II material and shipping charges.

The baseline or competing alternative against which the performance was compared is cement solidification with off-site disposal. Grouting (Cement Solidification) and off-site disposal is the presumptive technology at small arms firing ranges and is well-researched and well-used. Grouting is almost always used to treat for off-site disposal, and so is not an on-site treatment technology. The costs associated with grouting and off-site disposal are approximately \$104/yd^3. Cost was generated from pilot-scale treatment costs observed at CSSA and include a 14% by weight, mixture of Portland Cement and an off-site disposal cost as a Class 2 non-hazardous waste.

This demonstration validated the efficacy, cost-effectiveness and most importantly, the reduction in bioavailability obtained by using the PIMS technology for soil remediation of lead-contaminated soils. The demonstration also showed the value of the PIMS technology for use in other firing and ordnance range applications. The cost savings and ease of operation were the benefits of this technology at this site relative to all other remediation technologies.

SECTION 1
INTRODUCTION

1.1 BACKGROUND

Lead-contaminated soils are prevalent in the United States, particularly at Department of Defense (DoD) sites that have small arms firing ranges, detonation sites or testing facilities. Lead is the principal component of projectiles (bullets) used at small-arms firing ranges. Consequently, assessment and cleanups at these sites focus predominantly on the presence of lead in soils and other environmental media. Lead is chemically stable and is not biodegradable. High levels of lead and lead compounds are known to induce disease and toxicity in high risk receptors, e.g., children and pregnant women (U.S. Environmental Protection Agency [USEPA], 1994). The Center for Disease Control (CDC) has repeatedly lowered the human blood level of concern from 40 micrograms per deciliter (μg/dL) in 1978, to 25 μg/dL in 1990, to the current blood level of concern of 10 (μg/dL).

A nationally recognized safe lead concentration in environmental media has not yet been developed. Lead is ubiquitous and can occur naturally in surface and shallow soils at concentrations ranging from 5 to 50 parts per million (ppm). Therefore, USEPA has focused predominantly on reducing the potential for sensitive populations to be exposed to anthropogenic (human-made) lead sources (e.g., industrial emissions, leaded gasoline, and paint) and environmental media contaminated with lead as a result of human activities, e.g., sites of mineral extraction, smelting operations, and firing ranges.

To address lead-contaminated media from human activities, several treatment methods have been used or proposed that involve extraction, removal, solidification, or stabilization/sequestration. Extraction is the actual removal of particulate and dissolved lead from the system leaving a relatively lead-free material that can stay on-site, with separate disposal or disposition of the extracted lead and any associated materials. Removal refers to the complete removal of the contaminated soil material for disposal elsewhere. Solidification is the encapsulation or physical adhesion of waste on a micro or macro scale into a more solid material, often in preparation for removal or disposal elsewhere. Stabilization is the alteration of contaminants into a less soluble, less mobile, or less toxic form to be either removed and disposed elsewhere, or to be left in place. Stabilization can also be thought of as sequestration in which an additive or process causes the lead to be sequestered either by precipitation in a new phase or sorbed onto an existing or added phase.

The Phosphate-Induced Metal Stabilization (PIMS™) technology discussed in this report is a stabilization or sequestration technology. Like PIMS, many stabilization technologies use an additive to the contaminated soil that immobilizes the metal or renders it non-toxic, but does not change the basic nature of the soil, e.g., its permeability or porosity. These technologies allow the soil to function in the future as a soil, to be left

in place or disposed of as a non-hazardous material. Solidification technologies, such as grouting or *in situ* vitrification, immobilize the metal by changing the basic nature of the soil, effectively rendering it a non-soil, which may or may not fit the desired future uses for the site.

Several categories of technologies are potentially applicable to lead-contaminated sites, and a few representatives of each are listed below. Each technology has specific advantages depending upon the site, the desired outcome, and future uses envisioned for each site. Five of these technologies have been demonstrated by Parsons, Inc., at Camp Stanley Storage Activity (CSSA), and are used for direct cost and performance comparisons for this site.

SOLIDIFICATION

Cement Solidification - Grouting (Cement Solidification) and Off-Site Disposal is the baseline technology at small arms firing ranges. This is a conventional cement-based process in which materials are mixed with Type I Portland® cement, or other cements, to encapsulate (solidify) the lead and render the lead immobile. The alkaline nature of cement also ensures that the treated material will pass a toxicity characteristic leaching procedure (TCLP) test. There is a significant increase in volume, depending upon the formulation, that ranges anywhere from 6% to 25%. Grouting is almost always used to treat for off-site disposal, and so is not considered an on-site treatment technology.

Other solidification technologies that were not demonstrated at CSSA include asphalt emulsification fixation and reuse, HWT 20 solidification and pozzolanic siliceous and aluminosilicate solidification.

STABILIZATION THROUGH SEQUESTRATION

Phosphate-Based Chemical Fixation - Phosphate-based stabilization methods involve the formation of relatively insoluble lead phosphate phases, the pyromorphite mineral group, by applying sufficient quantities of various types of phosphate materials directly into lead-contaminated soils. These phosphates include particulate materials such as apatites (hydroxy calcium phosphate minerals), di- and tri-calcium phosphates, soluble agricultural-grade phosphate fertilizers that are physically mixed into the soil, and phosphoric acid, or other phosphate-based liquids that are sprayed onto the material and/or mixed into the material. Sometimes other additives are used to increase the efficiency of the phosphate for precipitating specific minerals, such as adding gypsum to phosphoric acid to induce apatite precipitation.

PIMS - The PIMS field demonstration project discussed in this report is this type of phosphate-based chemical stabilization method using an apatite-type phosphate material, referred to as Apatite II™. Apatite II is manufactured from fish cannery waste products. In the manufacturing process 65-75% of the organics are removed from the fish bones and fish hard parts. This leaves a fish bone and fish hard part material that is primarily hydroxy calcium phosphate with residual organics of 25-35%. The WholeBone Apatite

II material is gravel-size and is used in permeable reactive barriers and in tank filters. Apatite II is crushed to a sand-size called Apatite II Onekrush™ for use in soil mixing. Apatite II can be further crushed to a clay-to-silt-size called Powder for injection applications. The manufacture of Apatite II generates no hazardous wastes and has no environmental concerns associated with it. PIMS using Apatite II induces the precipitation of lead-pyromorphite whenever lead is in solution in the soil water (Conca et al., 2000). In the pyromorphite phase, the bioavailability of the lead is significantly decreased, is highly stable for geologic time, and will not migrate. Apatite II is stable within the soil matrix and continues to act for many years after emplacement as new lead leaches from various primary contaminant phases, e.g.; lead pieces and lead particulates, and soluble lead minerals like lead oxides and lead carbonate. Apatite II will sequester leachable lead up to at least 20% of the mass of Apatite II used. The residence time of PIMS with Apatite II is much greater than other phosphate based chemical fixation technologies because the continued presence of the solid Apatite II in the soil for decades, probably centuries, supplies phosphate to the soil to induce precipitation whenever soluble lead becomes present. Therefore, its ability to continue to react with any subsequently leached lead from a waste or contaminated media forming insoluble pyromorphite allows the PIMS treated waste to continue to meet waste classification criteria. Because the treated material passes TCLP tests and reduces the lead bioavailability and lead leachability, the treated soil can either be left in place or disposed of as non-hazardous material, depending upon the site use and regulatory goals. PIMS using Apatite II was the only phosphate technology demonstrated at CSSA.

Phosphate Rock and Mineral Apatites – Like Apatite II, other solid forms of natural apatite minerals can be used, primarily mineral apatites mined as phosphate rock in various states such as Florida, North Carolina, Tennessee and Montana. While relatively inexpensive, these minerals have high levels of metals already in their structure, particularly lead, cadmium, arsenic, uranium, and thorium, and open pit mining of these minerals has caused extensive environmental issues in Florida, particularly with respect to radon and metals contamination in runoff (see the Florida Institute of Phosphate Research publication list at http://www.fipr.state.fl.us/publications). These minerals also serve as the main source of phosphoric acid for the phosphate-based liquid technologies and have the same environmental concerns in their manufacture.

Manufactured Phosphate Chemicals – Phosphate chemicals, fertilizers and liquids can be applied to induce metal stabilization, and many have been tried successfully. They induce precipitation of the soluble lead into stable phosphate phases, but these phosphate materials are not long-lasting in the environment and so cannot treat future lead that comes into solution in the soil as the primary lead phases continue to leach lead into the soil water. Additionally, the processes used to manufacture phosphoric acid leave a legacy of environmental degradation that will have to be dealt with at some point in the future.

EXTRACTION

Bioremediation/Phytoremediation - Of all the bioremediation methods, phytoremediation is the only one applicable to soils and materials present at sites such as CSSA. Phytoextraction is the removal of inorganic contaminants from above-ground portions of the plant (Anderson and Coats, 1994). When the shoots and leaves are harvested, the inorganic contaminants are reclaimed or concentrated from the plant biomass. The advantages of phytoremediation are the low input costs, soil stabilization, pleasing aesthetics (no excavation), and reduced leaching of water and inorganic contaminants in the soil. The limitations of phytoremediation are extended operations and maintenance (O&M) effort over many years, the plant must be able to grow in the contaminated soil or material, and the soil diffusion/transport of metals to the rhizosphere must be sufficiently fast and complete to allow uptake of most metals from the soil relative to leaching to groundwater. However, if working correctly the plant bio-mass will be contaminated above hazardous criteria and thus would necessitate proper handling and disposal which leads to increased costs. Phytoremediation is passive but will take up to 20 years or more for contaminant concentrations to reach regulatory levels at range sites. Therefore, phytoremediation is not appropriate for sites that pose an immediate threat or risk to human health. Phytoremediation requires a long-term commitment at the site to ensure adequate plant growth, which may not appeal to clients who require rapid cleanup. No actual lead-contaminated range site has been successfully treated with phytoremediation.

Electrokinetic Remediation - Laboratory experiments using electrokinetic remediation of heavy metals have demonstrated that certain pollutants dissolved in an aqueous phase can be removed by electroosmosis and electromigration, and this may prove to be a useful onsite remediation technology. An electric current transports dissolved metals through the soil water towards the electrodes placed in the ground. Permeabilities require saturated or near-saturated soil conditions, and acidic soil-water pHs are required to keep the metals in solution, so alkaline soils are not amenable to this technology. The reproduction of field conditions in the laboratory has proven difficult. Only small laboratory scale and bench-scale studies have been successfully performed on metal-contaminated soils using electrokinetic remediation, and it is unlikely that large throughput volumes can be achieved at most sites. Electrokinetic remediation was unsuccessfully attempted at Camp Stanley.

Solidification or stabilization is recognized by the USEPA as an effective remediation process for treatment of soils contaminated with lead and other metals (USEPA, 1997). If stabilized to remain on-site, the lead will remain in the system and long-term monitoring and record-keeping may be necessary to ensure that the treatment remains effective. The primary goals for solidification/stabilization at lead-contaminated sites are to:

- reduce the TCLP leachable lead levels to below the TCLP hazardous waste criterion of 5 mg/L, or the universal treatment standard for soil of 7.5 mg/L, so that the soil is no longer a hazardous material,

- reduce the field leachate lead levels exiting the site to below the USEPA drinking water standards (MCL) of 0.015 mg/L so that the soil poses no threat to groundwater or drinking water; and

- reduce the bioavailability of the lead to plants, animals, and humans.

PIMS is a technology that stabilizes many metals using the natural additive, Apatite II. Apatite II chemically binds soluble metals into new stable, insoluble phases in which the metal is no longer mobile and is less bioavailable. The PIMS technology is particularly suited to lead stabilization. The soil remediation demonstration at CSSA in Boerne, Texas used mixing of Apatite II into lead-contaminated surface soils under unsaturated conditions at the Solid Waste Management Unit (SWMU) B-20, a former open burn/open detonation (OB/OD) area. This demonstration included a laboratory feasibility study, a pilot-scale test on 500 cubic yards of lead-contaminated soil, and a full field-scale demonstration on 3000 cubic yards of lead-contaminated soil. The pilot and field scale activities included site monitoring and post-emplacement testing. The PIMS demonstration, described in this report, succeeded in all three of the above goals.

1.2 OBJECTIVES OF THE DEMONSTRATION

The objective of this demonstration was to treat lead-contaminated soils at an ordnance treatment unit so the soil poses no further health threat or environmental hazard and can be released back to the site in a manner consistent with regulatory approval and future site use plans. This demonstration served two purposes:

1) Validate the efficacy of the technology in the field at a full-scale operation by:

    - demonstrating the use of PIMS with Apatite II for stabilizing/remediating particulate lead *in situ,*
    - determining actual field implementation costs.

2) Transfer the technology to an end-user (e.g.; CSSA), by:

    - determining degree of regulatory acceptance;
    - actually remediating the lead-contaminated soil at SWMU B-20 at CSSA; and
    - providing the base with an acceptable *in situ* alternative to off-site disposal or reduce off-site disposal cost through treatment of soil to a lesser waste classification.

The contaminant is particulate lead in soil from ordnance and firing range activities. The soils had previously been excavated, sieved, and placed into six approximately 500-750 cubic-yard (yd^3) piles. One 500 yd^3 pile was used for the Phase I pilot-scale test, and the remaining soils, less approximately 10 yd^3, were used in the Phase II field-scale demonstration. CSSA has been the lead in this demonstration, and all activities were coordinated by them and their subcontractor, Parsons, Inc (Parsons). These activities fall under Parsons site protocols, regulatory umbrella, and Quality Assurance Project Plan (QAPP), including analytical chemistry. There have been two Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFI) at the SWMU B-20 site, and some of that information is incorporated into this report.

This demonstration validated the efficacy of the PIMS technology for soil remediation of lead-contaminated soils and for other firing and ordnance range applications. The cost-savings, ease of operation and reduction in bioavailability were the benefits of this technology at this site relative to the other technologies described in the above section.

1.3 REGULATORY DRIVERS

The USEPA Region VI and the Texas Commission of Environmental Quality (TCEQ, previously the Texas Natural Resource Conservation Commission) are the two agencies having regulatory authority, and both are requiring mitigation of these lead-contaminated soils. Both agencies have expressed support for this demonstration and have hopes that its success will lead to accelerated clean-up of similar sites in Texas and elsewhere.

The RFI and closure of SWMU B-20, a former OB/OD area, is being conducted by Parsons and CSSA in accord with a Compliance Order dated June 30, 1993. Additionally, an Administrative Order on Consent was entered into between CSSA and the USEPA, Region VI, proceeding under § 3008(h) RCRA, dated May 5, 1999. The Compliance Order required the SWMU B-20 closure plan to comply with federal and state regulations (40 Code of Federal Regulations [CFR] 265 Subpart G, and Title 30 Texas Administrative Code [TAC] Chapter 335 Subchapter S, respectively) for closure of hazardous waste management units. The Administrative Order requires RCRA investigations and closures of all solid waste management units and cleanup of impacted media (i.e.; groundwater and soils). Interim measures, specified in the Administrative Order, require interim measures to address stockpiled contaminated soils generated during unexploded ordnance (UXO) removal actions in 1997. This project provides data for determining if the remaining soils, which were generated during the 1997 UXO removal actions, can be adequately addressed by in-situ chemical stabilization and closure without off site disposal.

Success of a demonstration of this type is determined by the current applicable closure criteria, i.e., Texas Risk Reduction Program (TRRP) closure criteria - Texas Tier 1: remediation to risk-based numbers with no deed restriction required. Ongoing

discussions with base personnel and regulators will ultimately determine these levels and acceptable values and standards for closure.

During the Phase I pilot-scale test, the PIMS material was mixed with contaminated soil and placed in a lined area equipped with a leachate collection system. All leachate was collected and analyzed to confirm that contaminant concentrations were below the MCL criteria for lead. The Phase I effort, which treated 500 cubic yards of lead impacted soils from SWMU B-20, was placed in an area known as B-10 because of its proximity to available utilities (i.e., water and electrical power). In order to prevent additional State of Texas Pollution Discharge Elimination System (TPDES) permitting activities the Phase I pilot-scale demonstration collected all generated leachate for evaluations of the efficacy of the removal of lead to acceptable levels. The field monitoring of the site after treatment has shown that all lead leachate concentrations were below regulatory levels, and has demonstrated movement of soluble lead from the particulate phase to precipitation as insoluble lead phosphates associated with the Apatite II stabilizing agent. Therefore, Phase II field-scale demonstration efforts could be initiated at the site of generation, SWMU B-20, without the TPDES permitting requirements.

Following the Phase I pilot-scale demonstration, the Phase II full field-scale demonstration was conducted to determine actual field implementation costs and the implementation protocols for the application of PIMS. The Phase II field-scale demonstration included treating the remaining lead-impacted soils at SWMU B-20 with Apatite II Onekrush, as well as moving the soils treated in Phase I and incorporating them into the SWMU B-20 demonstration/treatment site, and finally covering all treated soils with a layer of uncontaminated surface soil and a vegetative cover which further isolated the treated soil from contact with the public or the environment. Although this technology does not meet the current closure criteria, which requires removal or remediation of all waste or waste residue, it is expected to meet the risk based closure standards with the data generated supporting the evaluations of risk to human health and the environment.

Recent studies conducted at the Columbia School of Public Health for the USEPA show that the use of phosphate-amendment to lead contaminated soils reduces the bioavailability of lead to adult humans (Graziano et al., 2001, 2003). Further discussions regarding risk associated with CSSA soils are given in Section 4 of this report.

1.4 STAKEHOLDER/END-USER ISSUES

The outcome of this demonstration determined whether CSSA and the DoD will use this technology in the future. This successful demonstration should lead to widespread use of the technology, as this technology is a cost-effective alternative to other applicable technologies currently available. Additionally, the Interim Measures, as specified in CSSA's Agreed Order could be completed if demonstration results and regulatory acceptance are favorable.

1.5 REPORT ORGANIZATION

For this technical report, Section 1 provides an introduction and site-specific demonstration objectives. Section 2 describes the technology while Section 3 discusses the demonstration design and field actions performed. Section 4 summarizes the performance assessment and the risk assessment, evaluates attainment of objectives, and compares this technology with other technologies. Section 5 provides a cost assessment of the demonstration and Section 6 discusses any implementation issues with the use of the PIMS technology. References cited in this report can be found in Section 7. Section 8 provides a contact listing of stakeholders for this demonstration.

SECTION 2
TECHNOLOGY DESCRIPTION

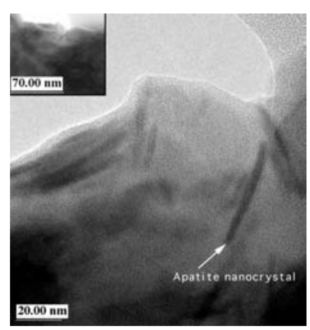
2.1 TECHNOLOGY DEVELOPMENT AND APPLICATION

The PIMS technology is ideal for remediating metal-contaminated systems, particularly lead (Conca et al., 2000; Conca and Wright, 1999; Lower et al., 1998; Ma et al., 1993). PIMS is suitable for all types of soils and waters, and all contaminant concentrations from parts per billion to percent levels. This technology is not affected by most environmental conditions and will work within most media from pH 2 to 12, at all moisture contents, and in the presence of organics and a thriving ecology. PIMS will not adversely affect existing biota, is not hazardous or toxic, and is beneficial to existing and future ecologies.

PIMS uses a special reactive form of the mineral apatite, Apatite II that chemically binds soluble metals into new insoluble solid phases (Wright *et al*., 1995; Chen *et al*., 1997 a,b; Conca, 1997; Conca, 1998, Wright et al., 2003). Apatite II is manufactured from fish cannery waste products, producing a fish bone and fish hard part material that is primarily hydroxy calcium phosphate with residual organics of 25-35%. In this case, Apatite II binds lead into lead-pyromorphite, an insoluble phase that is stable over all environmental conditions for hundreds of millions of years (Wright et al., 1987a,b; Wright, 1990). Lead-pyromorphite has an extremely low solubility product, $K_{sp} = 10^{-80}$, and will not dissolve under most environmental conditions. The lead in lead-pyromorphite is also not bioavailable. Apatite II will stabilize about 20 percent of its weight in lead. Similar performance occurs with uranium, plutonium, and other metals.

Some form of apatite is necessary for this technology. Non-apatite phosphate and mixtures of precursor constituents will not work as well or over as long a time period. Apatite II provides phosphate to precipitate lead pyromorphite. Apatite II also provides nucleation sites for precipitation of the lead minerals. Other apatites do not have the optimal chemical and structural properties for metal remediation in the environment. The high performance of Apatite II comes from a set of unique properties:

- Apatite II has no fluorine substitution in the hydroxyl position,
- Apatite II has a high degree of carbonate substitution,
- Apatite II is generally amorphous with random nanocrystals of apatite,
- Apatite II has few trace metals, and
- has a high degree of microporosity and surface area.



HR-TEM image of Apatite II showing general amorphous nature with random nanocrystal inclusions of crystalline apatite (low–resolution image is inserted in upper left corner).

The ultimate driving force for the robust performance of reactive phosphate with respect to metals is the extreme stability of these metal-phosphate phases, some of which are listed in Table 2.1. These metal phosphates are 20 to 70 orders of magnitude less soluble than quartz. Combined with this stability, the rapid kinetics of the metal-phosphate precipitation ensures immobilization of the metals in the face of most possible transport mechanisms in the environment.

Table 2.1
Stability of Apatite Minerals

Mineral Phase	Solubility Product (log K_{sp})	Mineral Phase	Solubility Product (log K_{sp})
$Pb_5(PO_4)_3(OH,Cl)$	-76.5	$Am(PO_4)$	-24.8
$Ca(UO_2)_2(PO_4)_2 \bullet 10H_2O$	-49.0	$Pu(PO_4)$	-24.4
$Sr_5(PO_4)_3(OH)$	-51.3	UO_2HPO_4	-10.7
$Zn_3(PO_4)_2$	-35.3	Quartz (SiO_2)	-4.0
$Cd_3(PO_4)_2$	-32.6	Salt (NaCl)	0.0

2.1.1 Typical Emplacement Methods

Site-specific questions regarding PIMS involve how to emplace the Apatite II or how to bring the soluble metal into contact with the Apatite II. The following are typical emplacement methods.

Soil mixing is a method in which Apatite II Onekrush is mixed with the contaminated soil so that when soluble metal is mobilized or when metal dissolved from lead particulates in the future is subsequently mobilized it contacts the and precipitates as the insoluble pyromorphite mineral. The amount of Apatite II added depends on the metal inventory and other site parameters but is between 2% and 5% for most soils. This stabilization method treats mobile soluble metal as it begins to migrate, not the particulate metal as it exists in the soil. This stabilization method does not remove metal from the soil but sequesters the metal against future leaching. This application was used at Camp Stanley, demonstrated at two military sites in California, used in combination with windrowing in Sweden and England, and demonstrated in Seoul, South Korea for use at a former train yard/metal plating operation site and a large OB/OD area.

A permeable reactive barrier of Apatite II WholeBone, emplaced in a trench downgradient of contaminated groundwater or contaminant sources, is a method that treats the soluble metal in the water as it moves through the barrier and immobilizes the metal as an insoluble metal-phosphate phase, such as lead-pyromorphite. The size of the barrier depends on the expected metal inventory, geometry of the plume, and desired treatment period. This method removes soluble metal from the groundwater. Apatite II

can be used in combination with other reactive media, such as zeolites, iron filings, or a biobarrier for treating a mixed waste plume, either mixed into the same barrier or into a sequential multi-barrier configuration. This application is being used for remediation of acid mine drainage in northern Idaho.

A reactive filter system using Apatite II WholeBone or Onekrush, placed in a process waste stream , similar to a granulated activated carbon (GAC) system, causes lead to precipitate, thus removing the metal before additional treatment to the waste stream may occur. The size of the reactor filter system depends on the expected metal inventory, and desired treatment period. This method removes soluble metal from the wastewater stream. Apatite II can be used in combination with other reactive media, such as zeolites, iron filings, or GAC for treating a mixed waste plume, either mixed into the same reactor or into a sequential multi-reactor configuration. This application is being used in Paducah, Kentucky, for U, Cd, Zn and Cu-contaminated waste water.

A liner or other disposal components composed of Apatite II Onekrush surrounding or underlying a site is a method in which the Apatite II treats leachate migrating out of a contaminated waste disposal site. Apatite II can be used alone or in combination with clay, grout, or other components. This method removes metal from the leachate as it leaves the system.

Using the Apatite II as an additive to a generated waste steam or treatment within waste containers is a method in which Apatite II Onekrush is added to the waste stream or within a container prior to disposal. Apatite II can be used alone or mixed with other constituents for mixed waste treatment. This method stabilizes the contaminant metal within the waste matrix before it is sent for disposal. Similarly, Apatite II can be added to a contaminated soil to reduce the hazard level of the soil to non-hazardous prior to disposal in a landfill as a non-hazardous waste, significantly reducing disposal costs. This hazardous waste treatment aspect of Apatite II was also used recently at Camp Stanley.

Slurry injection of Apatite II Powder for treatment of deep groundwater plumes. Fine-grained silt-to-clay-size Apatite II is injected as a slurry or dry-injected into wells and emplaced at depth to treat contaminants as they intersect the injected zone. Apatite II is being tested for both dry and wet injection.

2.1.2 The Approach at Camp Stanley

The general approach for using PIMS at CSSA is shown in Figure 2.1. Contaminated soils at SWMUs B-8, B-20, B-24, B-28, and the Demolition Dud area were excavated, ordnance pieces greater than three-quarters of an inch were removed, and soils were mounded into 18 piles of approximately 500 yd^3 each. Results from the feasibility study were used to select the contaminated media from SWMU B-20 for the ESTCP demonstration. The PIMS approach was split into two phases:

- Phase I – treat one pile of lead-contaminated soil by mixing it with 5 percent Apatite II. A landfill-type leachate collection system was emplaced below the treated soil to assist in determining performance, and to capture leachate generated in order to reassure regulators and meet the regulatory requirements associated with irrigating contaminated soil.. A clean gravel cover was placed over the site to prevent human and animal intrusion, and a thin underlayer of Apatite II was emplaced under the amended soil above the liner to insure against unexpected fast-path flow, poor mixing, or other adverse boundary conditions. Excessive irrigation was used to assure maximum leaching.

Phase I Site Photo

- Phase II-The Phase II field-scale demonstration included treating the remaining lead-impacted soil piles at SWMU B-20 by mixing them with 5% Apatite II, as well as moving the soils treated in Phase I and incorporating them into the SWMU B-20 demonstration/treatment site, and finally, covering all treated soils with a layer of uncontaminated surface soil and a vegetative cover, which further isolated the treated soil from contact with the public or the environment. A thin underlayer of Apatite II was not emplaced based upon Phase I results. A series of lysimeters was emplaced to catch the leachate water leaving the treatment zone. Because Phase II was a full field-scale remedial action for SWMU B-20, Phase II total costs could be used to calculate actual costs of this technology and did not require scaling of any parameter.

Phase II Site Photo

There are no key design criteria other than effectively mixing the soil and the Apatite II and emplacing it appropriately so it is stable from a slope-stability/soil-stability standpoint, e.g., it will not wash away in a flooding event. An actual 100-year flooding event did occur ten months after emplacement of Phase II, and no adverse effects were observed.

Figure 2.1 PIMS Soil Mixing for Lead Stabilization

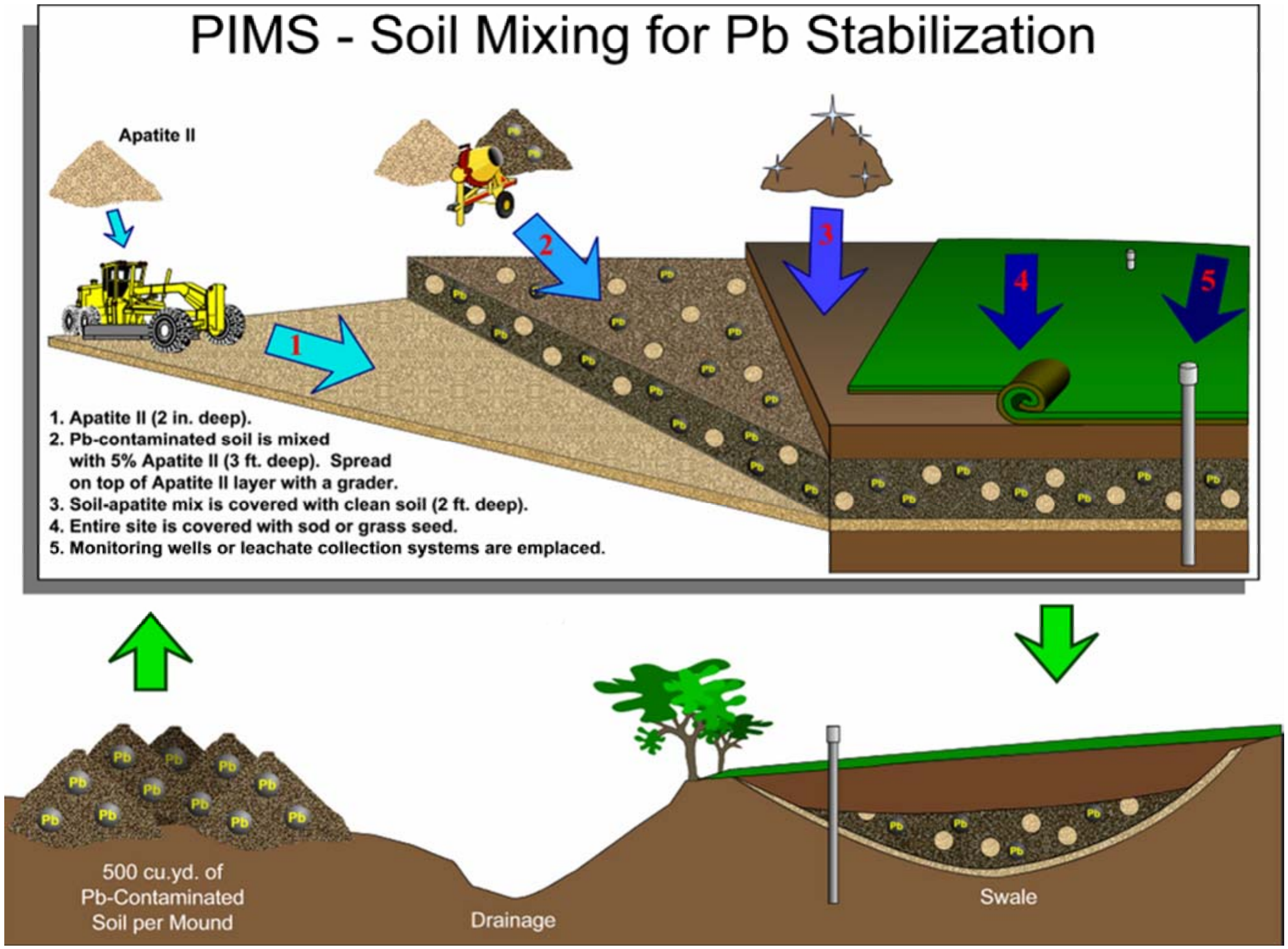


Table 2.2
Chronological Summary of Development of the Technology

1982-85	Judith Wright doctoral dissertation work in which she first demonstrates the stability of metals in fossil apatite over geologic time scales of hundreds of millions of years (Wright et al., 1987a, b).
1988-91	Judith Wright continues research on apatites and metals. James Conca joined the research effort.
1993-96	Judith Wright obtains SERDP funding to investigate the use of apatites in remediating lead. Performs work with James Conca at Washington State University laboratory.
1994	UFA Ventures, Inc. formed as a small business to investigate environmental problems and develop new technologies. Judith Wright and James Conca, principals.
1996-98	UFA Ventures obtains USEPA SBIR funding to develop PIMS using Apatite II for acid mine drainage.
1999-00	UFA Ventures obtains ESTCP funding for a field demonstration of PIMS. James Conca goes to Los Alamos National Laboratory (LANL). Judith Wright is President of UFA Ventures
2000	ESTCP Feasibility Study on CSSA soils performed by UFAV.
2000	Patent 6,217,775 awarded back to filing date March, 1998.
2000	PIMS NW, Inc. formed as a corporation in December. 2000
2001	Apatite II Permeable Reactive Barrier (PRB) emplaced at Success Mine, Idaho, to treat lead, cadmium and zinc acid mine drainage in January. Still successfully treating after 2.5 years and seven million gallons.
2001	ESTCP Field Demonstration Phase I (March) and Phase II (October) completed at CSSA.
2002	Four companies in the USA, UK and So. Korea sign licensing agreements with PIMS NW, Inc.
2001-03	Field monitoring and leachate collection at CSSA demonstrate no lead leaching above drinking water standards (0.015 mg/L) from the treated soil.
2003	Apatite II soil mixing demos successful and planning begins for use at military bases in California to treat lead-contaminated soils to non-hazardous levels for landfilling. A second Apatite II PRB emplaced in Idaho at Nevada Stewart Mine to treat acid mine drainage. A small Apatite II treatment tank emplaced at Department of Energy's Paducah facility to treat uranium, cadmium, zinc and copper in contaminated water flooding a processing facility.

2002-03 MSE-TA, Inc., MCL Inc., Slater UK, Ltd, BATU Enviro-Tek, Inc. become licensees, Parsons, Brice, AMEC, and several other U.S. contractors and foreign companies perform feasibility studies and field-scale demonstrations, and plan projects.

2.2 PREVIOUS TESTING OF THE TECHNOLOGY

Previous work with lead, zinc, cadmium, aluminum, copper, nickel, cobalt, uranium, americium, and plutonium has shown successful performance of Apatite II under a variety of environmental conditions. Under a SERDP project, UFA Ventures, Inc. (UFAV) investigated the metal-stabilization potential of reactive phosphates and other sorptive media in soil mixing and permeable reactive barriers at the Bunker Hill Mining District in northern Idaho. Soil at Bunker Hill was contaminated with lead, zinc, and cadmium up to 4,000 ppm, and groundwater's had concentrations of lead, zinc, cadmium, and copper up to 10 ppm, 250 ppm, 1 ppm and 20 ppm, respectively. Treatability studies using columns of soil mixed with various amounts of apatite showed that PIMS-treated soils did not leach any metal above detection limits of 5 parts per billion (ppb) for lead and cadmium, and 25 ppb for zinc). Even as little as 1 percent apatite by weight was effective. In permeable reactive barriers, Apatite II was orders of magnitude more effective than any other media, including bone char, mineral apatite (phosphorite), iron filings, zeolites, CabSorb, C-Sorb, and activated charcoal (Wright *et al*., 1995; Chen *et al*., 1997a; Conca, 1997; Conca, 1998; Conca et al., 2000). X-ray diffraction showed well-crystallized lead-pyromorphite precipitated in both the PIMS-treated soil and in the reactive barriers of apatite (Chen et al., 1997a).

Under a USEPA SBIR grant to UFA Ventures, Inc., the efficacy of emplacing a permeable reactive barrier to treat lead, cadmium, and zinc in seep waters from the Success Mine tailings pile was investigated. A feasibility study was performed on various materials, including different sources of apatite (three Apatite II formulations [Apatite WE, PR, and AP] and cow-bone apatite [Apatite CB]), mineral apatite phosphorite or phosphate fertilizer as well as reagent grade tricalcium phosphate, iron-filings, compost/woodchip/gravel mixture, two zeolites, a polymer used in remediation of mine wastes, and activated charcoal. The Apatite II performed best with respect to all metals. Results for zinc are shown in Figure 2.2, which plots contaminant concentration in the effluent normalized to the influent C/C_0, versus the volume of water passing through the column normalized to the weight of barrier material. Similar results occurred for cadmium (Conca, 1997).

Table 2.3
Results from PRB testing for the Success Mine Site

Entering Barrier (µg/L;ppb)					Exiting Barrier (µg/L;ppb)			
Date	**pH**	**Cd**	**Pb**	**Zn**	**pH**	**Cd**	**Pb**	**Zn**
1/20/01	---	---	---	---	7.0	< 2	< 5	14
3/23/01	4.5	333	1,230	44,700	6.0	< 2	< 5	27
6/1/01	5.0	413	1,400	58,500	7.0	8	65	900
8/20/01	4.5	379	1,290	53,700	6.5	6	11	775
10/27/01	5.0	437	1,110	71,300	6.5	< 2	< 5	74
1/10/02	5.0	779	1,210	116,000	6.5	< 2	< 5	66
6/27/02	4.8	726	1,450	57,230	6.9	< 2	< 5	243
8/02/02	4.2	430	1,185	64,600	7.1	< 2	< 5	83
10/19/02	4.5	414	1,030	68,350	6.5	< 2	< 5	69
11/10/02	4.5	428	869	65,600	6.5	< 2	< 5	39
12/16/02	4.5	474	926	83,950	6.5	< 2	< 5	91
3/14/03	4.5	650	1,190	48,700	6.6	< 1	< 1	55

As a result of these studies, the Idaho State Department of Environmental Quality proceeded with emplacement of an Apatite II permeable reactive barrier at the Success Mine site. Monitoring results from the field have shown excellent performance for the last 2.5 years, with the Apatite II keeping lead and cadmium below the detection limits of 0.005 mg/L, and zinc to below background.

Similar results were obtained for uranium during treatability studies of remediation of uranium-contaminated soils from a depleted-uranium firing range; the highly insoluble uranium-phosphate mineral, autunite, was precipitated on the Apatite II, and the soil was cleaned up to below the release criteria for placement back to the site. Apatite II was also successfully tested as a liner in treatability studies to prevent plutonium from leaching and escaping waste disposal drums (Conca et al., 2000).

2.3 FACTORS AFFECTING COST AND PERFORMANCE

Factors affecting cost of this treatment method include cost of the Apatite II (currently stable at about $350/ton plus shipping) and normal construction costs of soil handling, e.g., mixing, handling, etc., which are also well established and stable. Performance will be only slightly affected by how much Apatite II is used and how well it is mixed (all previous benchscale treatability studies purposely used gross mixing techniques to reflect field conditions and varying ratios of Apatite II to soil). Soil type will slightly affect the cost by affecting soil water chemistry, but since CSSA soils are a worst-case soil type, the costs determined from the Phase II demonstration will be conservative. Climate will only slightly affect performance of the demonstration, except for tundra conditions in which the soil is frozen, or other unsuitable conditions for soil mixing (e.g.; large debris within the soil matrix).

2.4 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

The advantages of this technology include:

- The ability to use as an in-situ treatment technology;
- Its relatively low cost compared to other stabilization technologies; and
- The ease of application and its limited or no maintenance requirements.

Additionally, as Apatite II is generated as a waste product from the fishing industry, its use as a product further enhances the advantages of the PIMS technology over other phosphate technologies. This is in part because other agriculture grade or reagent grade phosphates require production from phosphorite or other applicable minerals and, as such, create excessive waste and environmental hazards through their production.

The main limitation of this technology is that lead is not removed from the system, but stabilized within the system. However, this technology is applicable to risk-based closures because of the reduction in lead bioavailability and leachability. Frozen soils, or other unusual conditions that make mixing impossible or prohibitively difficult, are not appropriate for this technology.. Apatite II, because it is derived from fish bones, has a fish odor associated with it, and should be stored under cover and kept dry until used.

SECTION 3
DEMONSTRATION DESIGN

3.1 PERFORMANCE OBJECTIVES

Performance objectives were to determine suitable emplacement methodologies for the *in situ* treatment of lead-contaminated soils so the soil poses no further health threat or environmental hazard, and to determine actual field implementation costs.

Table 3.1 provides an assessment of the performance objectives. Results of leachate monitoring proved that soils treated with PIMS prevented the leaching of lead to surface runoff, upper soil horizons or stormwater at concentrations over the maximum contaminant level (MCL) of 15 ppb. Therefore, emplacement of the PIMS material using common field equipment (e.g., backhoe/front-end loader) is appropriate and represents a significant factor in determining actual field implementation costs.

Table 3.1 Performance Objectives

Type of Performance Objective	Primary Performance Criteria	Expected Performance (Metric)	Actual Performance Objective Met
Qualitative	*1. Reduce Pb mobility*	*<15 ppb Pb in leachate from treated site soils (USEPA)*	***Yes***
	2. Faster remediation	*< 2 week field implementation*	***Yes***
	3. Ease of Use	*Easy soil mixing*	***Yes***
	4. Reduces Pb bioavailability	*In vitro testing shows lower bioaccessibility*	***Yes***
Quantitative	*1. Meet regulatory standard*	*<15 ppb Pb in leachate from treated site soils (USEPA)*	***Yes***

3.2 TEST SITE SELECTION

As this technology is ideally suited for lead-contaminated media, the test site was chosen because of its lead contamination. The site is also very representative of many other DoD sites, both in contaminant type and field characteristics. The site was also chosen because of enthusiasm by key players including the EPA representative, and stakeholders, and the good existing infrastructure at CSSA.

3.3 TEST SITE HISTORY/CHARACTERISTICS

3.3.1 Test Site History

The land on which CSSA is located was used for ranching and agriculture until the 1900's. During 1906 and 1907, six tracts of land were purchased by the U.S. Government

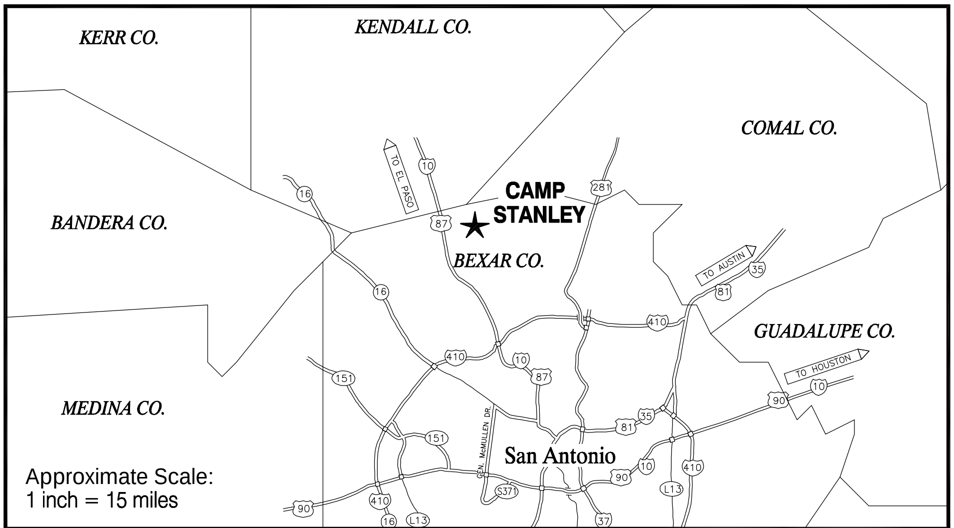
and designated the Leon Springs Military Reservation. The reservation was used for maneuvers by Army and National Guard units, and the lands included campgrounds and cavalry shelters. In October 1917, the installation was redesignated Camp Stanley Storage Activity (see Figure 3.1). U.S. involvement in World War I spurred extensive construction of temporary cantonments and installation support facilities. In 1931, CSSA was selected as an ammunition depot, and construction of standard and igloo magazines began in 1938 (Army, 1990). CSSA was transferred to the jurisdiction of the Red River Army Depot (RRAD) in 1947. In addition to ammunition storage, CSSA lands were used to test, fire, and overhaul ammunition components.

The field demonstration was conducted on soils primarily impacted with lead from a former OB/OD waste management unit (SWMU B-20). Other metals (i.e., barium, cadmium, chromium, copper, zinc, etc.) were also present in the site soils at above background concentrations.

SWMU B-20 was used periodically between 1946 and 1987 to treat and dispose of waste ordnance. During that period, ordnance and other waste was detonated, buried, and disposed of on the ground surface at the site. SWMU B-20 consists of approximately 33.5 acres surrounded by wooded areas in the northeastern portion of CSSA. The area is sparsely vegetated with grasses and cedar shrubs. Gravel roads form the south, west, and north boundaries of the site.

At the time that investigations began at SWMU B-20 in 1994, site features included an inactive bunker west of the western gravel road; a standpipe, reportedly used on one occasion for the static firing of a rocket motor; and an electrical junction box in the central portion of the site. Broken aboveground conduit was visible in the central-southeast area of the site. Fifteen craters were identified in the northern and central portions of the site. Six of these craters located in the northern portion of the site were presumably used during the early history of the site. Five mounds of soil from the site that were stockpiled for use in covering explosives prior to detonation were present in the eastern portion of the unit. At the time that investigations began, inert metal scrap and UXO was scattered across the entire site. In addition, waste was buried and on the ground surface in the northern portion of the site. During a 1997 waste and UXO removal action approximately 3,000 yd^3 of material were sifted. A total of 100,280 pounds of metal debris were removed and recycled. The sifted soils were stockpiled into six stockpiles between approximately 500 and 750 yd^3 each. Figure 3.2 shows the Phase II location within SWMU B-20.

A total of 18 samples were collected from the sieved soil material for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), explosives, and metals analysis. Analytical results of the samples indicate that VOCs and metal constituents are present in the stockpiled soils. SVOCs and explosives were not detected in the samples.



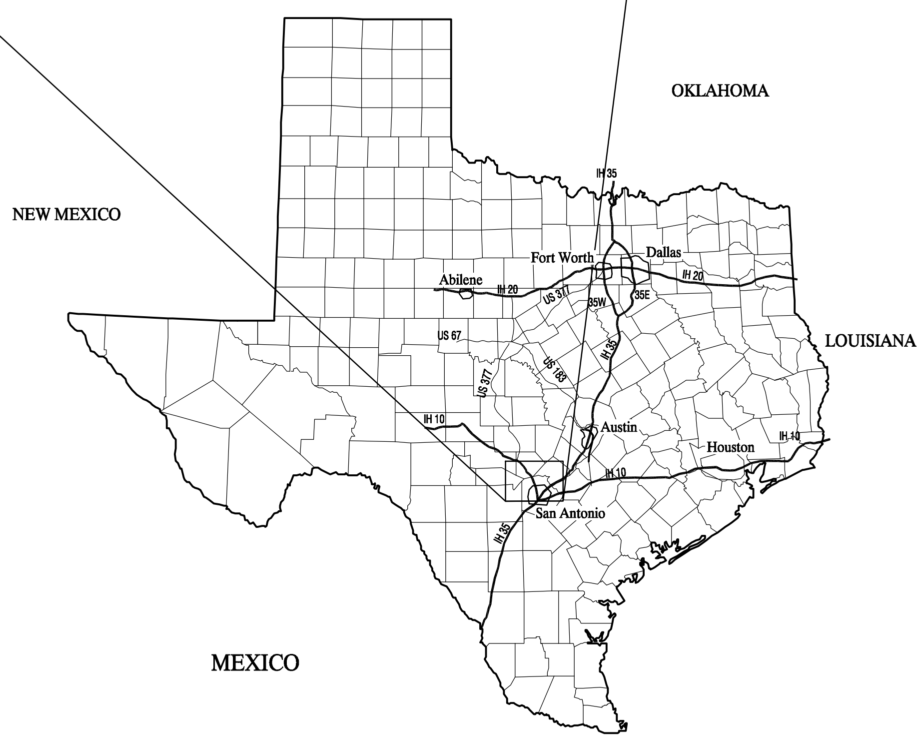


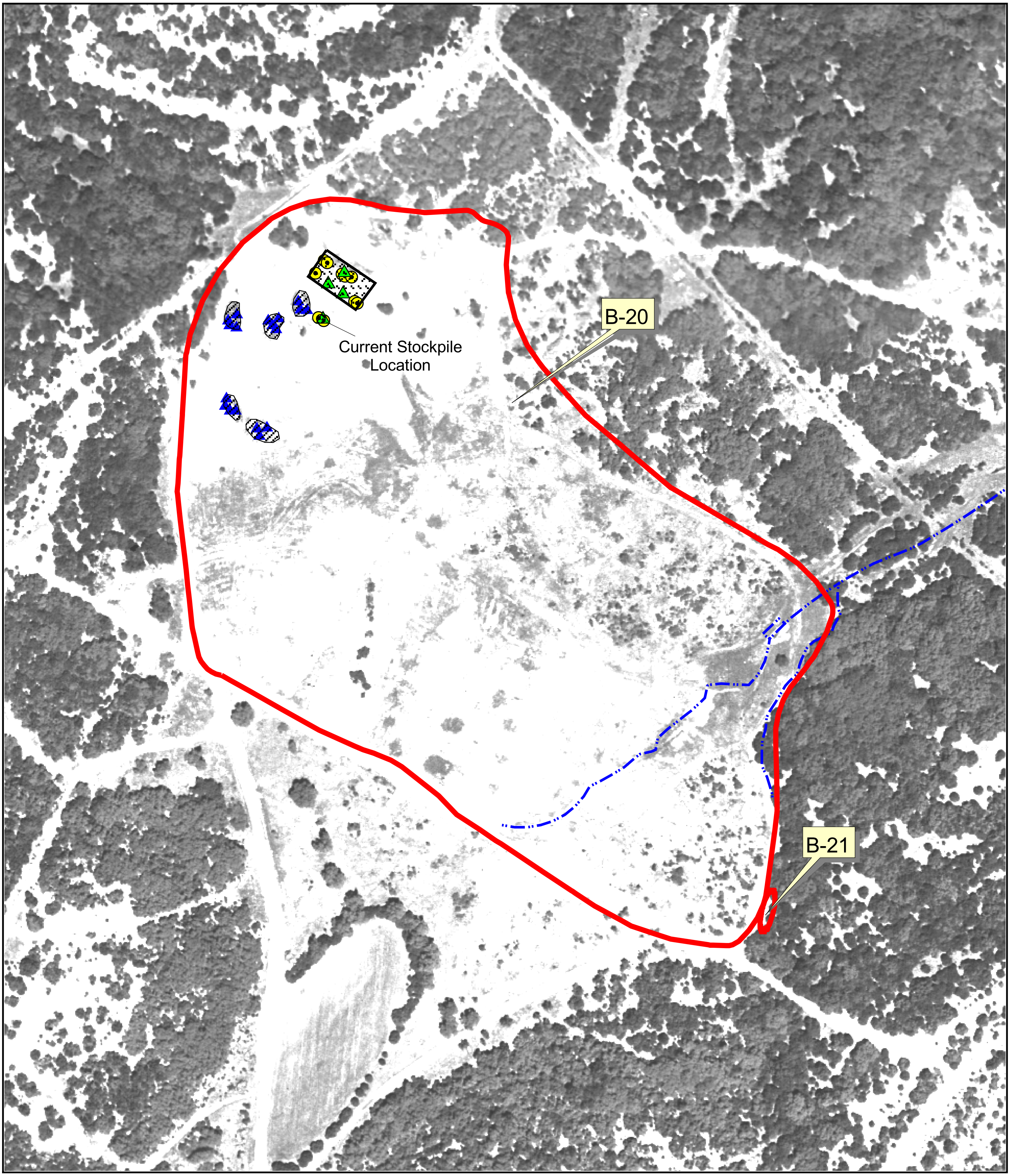
Figure 3.1

Regional Location Map

Camp Stanley Storage Activity

PARSONS

734521-14000 CSSA-SLM.DWG



N

300 0 300 Feet

Due to different margins of error associated with the various methods utilized for data point collection, all sample locations are approximate. For more information see the 2001 amendment to the Field Sampling Plan, Vol. 1-4 of the Environmental Encyclopedia.

- Sift Sample Locations
- PIMs Sample Locations
- Lysimeter Locations
- Stockpile Locations
- Former Stockpile Locations
- PIMS Phase II Field Study Area
- Creeks

Figure 3.2

SWMU B-20 Phase II Location Map

Camp Stanley Storage Activity

PARSONS

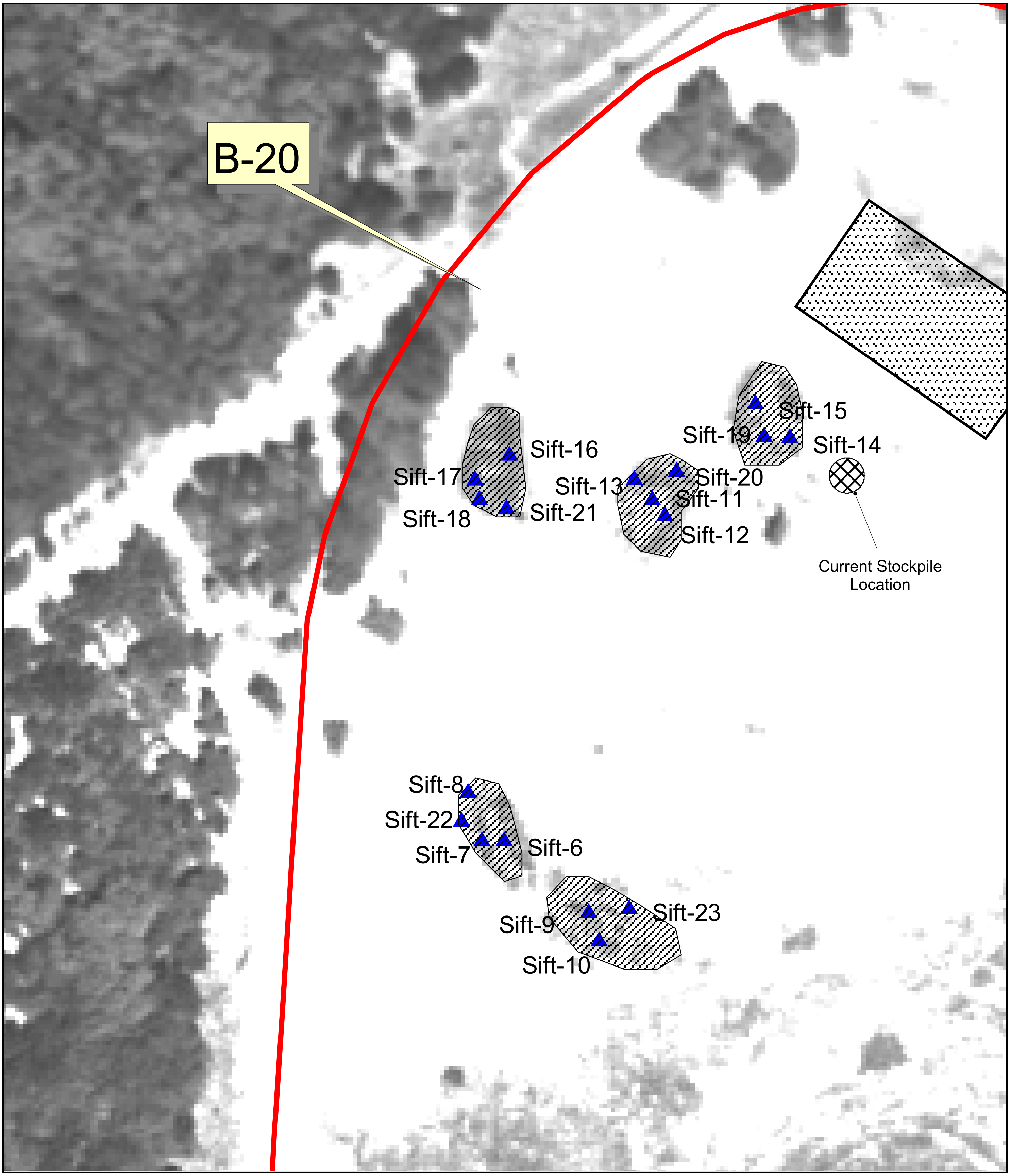
j:\730\730396\rl-33closurerpt.apr

Methylene chloride, toluene, and trichlorethylene (TCE) were detected at very low concentrations in the three sifted soil samples that were analyzed for VOCs. All VOC results were below analytical reporting limits (RLs). Methylene chloride was detected in B20-SIFT11, toluene was detected in B20-SIFT16, and TCE was detected in B20-SIFT06 and B20-SIFT16. However, concentrations of all these analytes were below RLs and therefore, below closure criteria.

One or more metals concentrations in every sieved soil sample exceeded CSSA background levels. As shown in Table 3.2, barium, copper, lead, and zinc concentrations most often exceeded background. Concentrations as high as 314 milligrams per kilogram (mg/kg) barium, 1,267.6 mg/kg copper, 40,509.44 mg/kg lead, and 478.5 mg/kg zinc were detected. Figure 3.3 shows the location of the characterization samples taken from the sieved soil material.

Table 3.2 Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000

		EPA METHOD / CONCENTRATION								
		SW7421 (mg/kg)	SW6010B (mg/kg)					SW7060A (mg/kg)	SW7131A (mg/kg)	SW7471A (mg/kg)
Date	Sample ID	Lead	Barium	Chromium	Copper	Nickel	Zinc	Arsenic	Cadmium	Mercury
03/28/00	B20-SIFT06	204.4	187.85	20.6	68.33	11.27	89.3	5.2	0.59	0.09
03/28/00	B20-SIFT06-FD	207.15	193.	19.9	97.95	13.83	104.82	5.0	1.15	0.13
03/28/00	B20-SIFT07	322.52	232.13	22.4	84.63	13.87	101.6	9.7	0.59	0.09
03/28/00	B20-SIFT08	446.78	264.73	22.7	85.18	13.41	110.48	5.1	0.86	0.08
03/28/00	B20-SIFT09	5,006.01	190.16	16.1	845.27	9.77	139.57	9.7	0.77	0.2
03/28/00	B20-SIFT10	2,704.96	200.46	20.6	125.73	11.83	121.72	9.9	0.85	0.16
03/28/00	B20-SIFT11	869.32	169.94	19.1	124.32	12.02	129.89	8.6	0.72	0.09
03/28/00	B20-SIFT12	386.56	127.12	14.7	82.15	9.42	87.9	9.0	0.71	0.15
03/28/00	B20-SIFT13	242.38	253.31	18.7	73.69	10.91	88.13	10.9	0.71	0.06
03/28/00	B20-SIFT14	40,509.44	203.42	20.4	800.58	11.7	167.68	3.3	0.66	0.34
03/28/00	B20-SIFT14-FD	504.18	256.13	20.2	145.16	12.31	155.64	14.6	0.71	0.25
03/28/00	B20-SIFT15	249.12	177.42	22.9	55.29	13.27	75.03	15.1	131.81	0.03
03/28/00	B20-SIFT16	2,278.26	235.32	18.6	102.33	10.68	97.86	12.0	0.85	0.27
03/28/00	B20-SIFT17	65.29	171.24	16.9	66.14	10.6	94.03	13.1	0.87	0.46
03/28/00	B20-SIFT18	1,627.22	117.18	12.3	31.88	7.17	42.21	10.9	0.6	0.19
04/21/00	RW-B20-Sift19	1,286.	219.2	24.1	236.6	14.6	478.5	4.9	0.66	0.024
04/21/00	RW-B20-Sift20	402.6	203.6	21.4	98.9	12.7	102.	5.5	0.52	0.13
04/21/00	RW-B20-Sift21	159.8	314.	23.3	62.4	13.5	85.1	5.8	0.67	0.69
04/21/00	RW-B20-Sift22	177.4	205.3	22.4	1,267.6	13.2	96.9	5.4	0.71	0.09
04/21/00	RW-B20-Sift23	23,550.	307.0	22.7	393.4	12.9	354.8	0.8	0.7	0.07



N

300 0 300 Feet

Sift Sample Locations

Stockpile Locations

Former Stockpile Locations

PIMS Phase II Field Study Area

Due to different margins of error associated with the various methods utilized for data point collection, all sample locations are approximate. For more information see the 2001 amendment to the Field Sampling Plan, Vol. 1-4 of the Environmental Encyclopedia.

Figure 3.3

SWMU B-20 Sift Sample Location Map

Camp Stanley Storage Activity

PARSONS

j:\730\730396\rl-33closurerpt.apr

Table 3.3
Summary of Metal Levels Above Background in Sifted Soil

Metal	Background Concentration (mg/kg)	Frequency of Above-Background Detection	Minimum Concentration (mg/kg)	Maximum Concentration (mg/kg)	Sample ID(s) with Maximum
Arsenic	19.6	0/20 (0%)	3.3	15.1	B20-SIFT15
Barium	186	15/20 (75%)	117.18	314	RW-B20-SIFT21
Cadmium	3.0	1/20 (5%)	0.52	131.81	B20-SIFT15
Chromium	40.2	0/20 (0%)	12.3	24.1	RW-B20-SIFT19
Copper	23.2	20/20 (100%)	31.88	1,267.6	RW-B20-SIFT22
Lead	84.5	19/20 (95%)	65.29	40,509.44	B20-SIFT14
Mercury	0.77	0/20 (0%)	0.024	0.69	RW-B20-SIFT21
Nickel	35.5	0/20 (0%)	7.17	14.6	RW-B20-SIFT19
Zinc	73.2	19/20 (95%)	42.21	478.5	RW-B20-SIFT19

3.3.2 Chronology of Events

The following chronology (Table 3.4) lists relevant activities at the B-20 unit since the first known use of the site in 1946.

Table 3.4
Activities at Site B-20
Solid Waste Management Units B-20 and B-21
Chronology of Actions/Investigations

Year	Month	Action/Results
1946-1987	NA	*B-20 area (approximately 33.5 acres) was used periodically for ordnance OB/OD activities.* *On an unknown date, sand and spent ammunition from the practice firing building at CSSA were disposed of at the B-21 area, which is immediately adjacent to B-20.*
1993	June	*A Compliance Order was issued for the B-20 site for unpermitted treatment of hazardous waste and for failure to have a closure plan.*
1994	January	*Preliminary samples were collected from the B-20 area to provide an estimation of the nature and extent of contamination for environmental investigation planning purposes.*
	March	*Partial Facility Closure Plan for B-20 (ES, 1994) closure/remedial investigation was submitted to USEPA Region VI and TNRCC.*
	November-December	*First phase of closure/remedial investigation was conducted at B-20. UXO was cleared from within the original site boundary, and geophysical surveys were conducted to identify anomalies in craters. Total of 812 UXO items removed.* *Surface soil, subsurface soil, surface water, and sediment were sampled and analyzed for metals and explosives. Surface water and sediment samples were also analyzed for VOCs. Barium, cadmium, lead, and mercury levels exceeded RRS1.*
1995	June	*Final Remedial Investigation Report (Parsons ES, 1995a) for B-20 submitted. Report recommended additional sampling and UXO clearing activities.*
	September	*Amendment to Project Plans (Parsons, 1995) submitted to regulatory agencies for second phase of sampling.* *Second phase of remedial investigation conducted. Subsurface soils sampled near three first phase remedial investigation (RI) borings to determine if metals failed synthetic precipitation leaching procedure (SPLP) test.* *Surface soils sampled in south-central portion of site to better delineate extent of metals contamination.*
1995	October	*USFWS sent a letter of concurrence for planned vegetation clearing activities at the B-20 site.*

Year	Month	Action/Results
	December	*Second Amendment to Project Plans (Parsons, 1995) submitted to regulatory agencies.*
1996	January - March	*Field activities conducted, including vegetation clearing to facilitate UXO identification, systematic sweep of surface for UXO with magnetometers within original site and perimeter, excavation and removal of buried UXO in craters, excavation and removal of buried UXO in northern 5 acres of site, and collection and disposal of scrap metal scattered over the surface of the site.*
	January	*All UXO items found on site to date (365 items) were detonated after receiving approval from TNRCC on January 29.*
	May	*UXO items identified since January 31 (447 items) were detonated on site.*
	June	*Addendum to the Remedial Investigation Report (Parsons ES, 1996b) submitted. Report recommended additional UXO clearing activities.*
1997	January	*Third Amendment to Project Plans for Remedial Investigation submitted.*
	January-September	*East extension to B-20 was cleared of vegetation and systematically swept for UXO. Soils from northern 5-6 acres of the site were sifted to remove UXO and metal scrap.*
	March-April	*Phytoremediation, soil washing, and stabilization bench-scale treatability studies conducted.*
1999	April	*EPA Memorandum indicated analytical results obtained from ITS laboratory are not usable for closure or compliance.*
	April	*TCEQ's early April inspection resulted in a requirement for B-20 waste removal. Initiated UXO investigation/mitigation actions for "Hot Soil" located at B-20. UXO removal was accomplished on approximately 80 cubic yards of soils at the B-20 site.*
	July	*"Hot Soils" contaminated with hazardous lead levels were transported and disposed of in accordance with applicable regulations. Approximately 100 tons of soils were removed from B-20.*
	November	*Submitted work plan for resampling to replace analytical chemistry data generated by ITS Laboratory.*

Year	Month	Action/Results
2000	March	*Advanced 8 borings for Rework (SB1-8) and collected 16 samples for explosives analysis.*
	April	*Collected 5 sift samples (Sift19-23 for rework) for metals and explosives analysis.*
		Collected 13 sift samples for VOCs, SVOCs, metals and explosives (3 samples) and metals only (10 samples).
	April	*Initiated Phosphate Induced Metal Stabilization (PIMS) field scale feasibility study project.*
2001	February	*Draft field demonstration work plan submitted to UFA Ventures and the ESTCP.*
	May	*Initiated Phase 1 field construction efforts for treatment cell located at SWMU B-10, and mixing approximately 500 cubic yards of lead contaminated soil with PIMS material from SWMU B-20.*
	June	*Submitted final field demonstration work plan and completed field mixing efforts and test cell construction.*
		Collected 2 soil samples from field demonstration site for total and TCLP lead analyses and total phosphate analysis. One sample from PIMS treated soils, and one sample from non-treated soils
	July	*Collected one sample (0.45 micron filtered) of initial leachate generated at test site for total lead analysis.*
	August	*Collected two samples (0.45 micron and 0.1 micron filtered) of leachate at test site for total lead analyses*
		Test Cell sump modified to improve flow capacity of water migrating through the treated soils.
	September	*Collected one sample from test cell water holding pond for total lead analysis.*
	October	*Initiated Phase II efforts, mixed PIMS material in remaining contaminated soils located at SWMU B-20 as an Interim Measure Corrective Action (IMCA).*
		Collected 8 soil samples from SWMU B-20 PIMS IMCA treated soils for TCLP lead analysis.

Year	Month	Action/Results
		Collected one sample from test cell water holding pond for total lead analysis.
	December	*Collected one leachate sample (0.45 micro filtered) from test site for total lead analysis.*
2002	February	*Collected two leachate samples (0.45 micron and 0.1 micron filtered) from test cell sump for total lead analysis.*
	July	*Collected two soil samples (one from PIMS treated soil and one from untreated soils) for bioavailability testing and total lead analysis at SWMU B-20 IMCA site.*
	April	*Collected three leachate samples (two 0.45 micron and one 0.1 micron filtered) from the SWMU B-20 IMCA site for total lead analysis.*
		Collected one soil sample from non-treated soils at SWMU B-20 IMCA site for total lead analysis.
	June	*Collected two leachate samples (0.45 micron filtered) from the SWMU B-20 IMCA site for total CSSA nine metal analysis.*
	July	*Collected two leachate samples (0.45 micron filtered) from the SWMU B-20 IMCA site for total CSSA nine metal analysis.*
		Final RCRA Facility Investigation Report for SWMU B-20 submitted.
		Re-installed Lysimeter 1 at SWMU B-20 IMCA site due to malfunction.
2002	August	*Initiated watering of SWMU B-20 IMCA site for collection of three synthetic leachate samples (O.1 micro filtered) for total CSSA nine metal analysis.*
	September	*Installed Lysimeter 4 located in non-treated soils for collection of leachate .for background conditions*
	October	*Collected four leachate samples (0.45 micron filtered) from the SWMU B-20 IMCA site for total lead analysis. Lysimeter 4 analysis also included the eight additional CSSA total metal analyses.*
	December	*Collected eight leachate samples (four 0.45 micron filtered and four 0.1 micron filtered) from the SWMU B-20 IMCA site for total CSSA nine metal analysis.*
		Removed Phase 1 treated soils and replaced material at the SWMU B-20 IMCA site. SWMU B-10 was then used as a staging area for the removal of SWMU B-3 waste materials. Lysimeter 4 was destroyed during the placement of the Phase 1 soils at the SWMU B-20 IMCA site.

Year	Month	Action/Results
2003	February	*Collected three leachate samples (0.45 micron filtered) from the SWMU B-20 IMCA site for total lead analysis.*
	March	*Re-installed Lysimeter 4 within non-treated SWMU B-20 soils. Collected three soil samples, one each from Phase 1, Phase II, and non-treated soils for bioaccessibility and risk assessment analysis.*
	April	*Collected an additional six soil samples, two each from the Phase 1, Phase II, and non-treated soils for additional bioaccessibility and risk assessment analysis.*
	May	*Phase 1 area was re-stored to original conditions with confirmation soil samples taken for total lead and zinc analysis.*
	May	*Collected three leachate samples (0.45 micron filtered) from the SWMU B-20 IMCA site for total lead analysis and for total CSSA nine metal analysis.*

3.3.3 Environmental Setting

Climate

CSSA is located in south-central Texas on the Balcones Escarpment. Northwest of the installation the terrain slopes upward to the Edwards Plateau; to the southwest, the terrain slopes downward to the Gulf Coastal Plains. This results in a modified subtropical climate, predominantly marine during the summer months, and continental during the winter months. Summers are hot with daily temperatures above 90°F over 80 percent of the time, and winters are mild with below freezing temperatures occurring on an average of only about 20 days per year. Temperature extremes have ranged from 0°F to 108°F.

CSSA is situated between a semi-arid region to the west and the coastal area of heavy precipitation to the southeast. Average annual rainfall is approximately 29 inches. Precipitation is fairly well distributed throughout the year, with the heaviest amounts occurring in May and September. Approximately 61 percent of rainfall occurs from April through September and is primarily due to thunderstorms. During this period, large amounts of precipitation may fall in a short period of time. Most winter precipitation occurs as light rain or drizzle; however, thunderstorms accompanied by heavy rain occur in all months of the year.

Topography

CSSA is characterized by a rolling terrain of hills and valleys in which nearly flat-lying limestone formations have been eroded and dissected by streams draining

primarily to the east and southeast. Physiography of the B-20 site is influenced by native topography, underlying geology, and artificial terrain modifications caused by explosive demolition and earth-moving activities. Fifteen craters resulting from demolition activities at the B-20 site range in depth from approximately 1 to 6 feet below grade. These craters were brought to grade in 1997.

Resistive limestone beds outcrop as topographic highs, but none form buttes or mesas. Rather, the predominant physiographic features are hills and "saddles" which lead to stream valleys. Topographic relief across CSSA ranges from about 1,100 feet to 1,500 feet above mean sea level (MSL). Elevations at the B-20 unit range from 1,360 feet above MSL on the west, to about 1,300 feet above MSL on the east.

Sinkholes are present at CSSA, primarily in areas where porous and fractured limestone formations are exposed. However, no sinkholes were observed or encountered during drilling activities at the B-20 site.

Drainage and Surface Water

River and stream dissection of limestone is the major surface feature at CSSA and the B-20 site. Most major rivers and streams originating in the Edwards Plateau to the northwest of CSSA tend to follow northwest-southeast regional fracture patterns. Drainage from CSSA generally flows in a southerly direction into Salado Creek and Leon Creek, with a small portion in the northeast draining into Cibolo Creek. Approximately 75 percent of CSSA is in the Salado Creek watershed, 15 percent in the Cibolo Creek watershed, and 10 percent in the Leon Creek watershed. All these streams are intermittent at CSSA. The B-20 site is located within the Cibolo Creek watershed, approximately 1.5 miles south of Cibolo Creek.

Drainage at the B-20 site is generally to the northeast in two runoff channels within the Cibolo Creek watershed. The larger channel begins just north of the gravel road at the southern site border, drains into a small pond, and continues northeast to the livestock pond. Surface area of the pond is less than one acre. An earthen dam exceeding 6 feet in height causes collection of surface water in the livestock pond. The smaller channel runs northeast along the eastern site boundary until it branches into the larger channel. Both channels are ephemeral, and the ponds are dry during periods of little to no precipitation. Due to higher elevations north, west, and south of the site, these two channels receive all site runoff.

Soils

Generally, soil types at CSSA are dark-colored, gravelly clays and loams. According to the USDA Soil Conservation Service (SCS) soil survey for Bexar County, Texas, soil types at the installation include Brackett-Tarrant association, Brackett soils, Crawford and Bexar stony soils, Krum complex, Lewisville silty clay, Tarrant association, and Trinity and Frio soils.

The soil horizon at the B-20 site is typically thin, ranging from 0.5 to 6 feet in thickness across the site. Only the Brackett-Tarrant association, Crawford and Bexar stony soils, and Krum complex occur at B-20. These three soil types are described in detail below.

Brackett-Tarrant association soils occur on hills in the west-central and northern portions of the B-20 site. Typically, Tarrant soils are on the tops and the upper sides of ridges, just above Brackett soils. Both soil types are underlain by Glen Rose limestone. Tarrant soils consist of a clayey, very dark grayish-brown, calcareous surface layer which is up to approximately 10 inches thick. Various amounts of limestone gravel occur within the profile. Brackett soils consist of grayish-brown, gravelly clay loam. Brackett soils are lighter colored, less clayey, and less stony than Tarrant soils. Brackett soils are also strongly calcareous.

Crawford and Bexar stony soils occur in the north-central and southeastern portions of the B-20 site on broad, level to gently undulating areas. Both Crawford and Bexar soils are moderately deep. The Crawford type soils have a dark grayish brown to dark reddish brown surface layer that is generally 12 to 16 inches thick. The subsurface layer is a blocky, reddish-brown, noncalcareous stony clay that developed over broken limestone. The pH of typical Crawford soils ranges from 7.5 to 8.0. The Bexar soils are dark reddish-brown, cherty clay loams or gravelly loams. The slope range for Bexar soils is 0 to 8 percent. Bexar soils are redder, less clayey, and more cherty than Crawford soils. The pH of typical Bexar soils ranges from 6.0 to 6.5.

The Krum complex soils are located in infrequently flooded streambeds such as those in the eastern and northeastern areas of B-20. Typically, these soils occupy foot slopes below Tarrant and Brackett soils. These soils receive runoff and additional sediments from higher lying soils. Krum complex soil is dark grayish-brown, calcareous, and ranges from silty clay loam to gravelly clay. The pH of typical Krum clay is 8.0.

3.3.4 Geology

Structure

The Balcones Fault Zone is a large regional fault system located in the Camp Stanley area. It is comprised of a series of high angle normal faults that generally trend in a northeast to southwest direction. In most cases, the northwest fault blocks have moved up in relation to the southeast blocks. Because of differential erosion associated with this movement, older rocks are typically exposed on the upthrown (northwest) block and younger deposits are typically found exposed on the downthrown (southeast) block. In northwest Bexar County, total displacement along this fault is approximately 1,200 feet. Regional dip in the area is on the order of 10 to 15 feet per mile. However, dips of up to 100 feet per mile have been noted within the fault zone.

Several northeast to southwest trending faults have been identified at CSSA. The fault zone in the central portion of the base is characterized as a series of several small

faults with displacements ranging up to a maximum of 30 feet. The fault along the southern base perimeter appears to be a single fault trace with displacement estimated at about approximately 65 feet. As a result of the regional faulting, many fracture systems have developed in the Cretaceous deposits.

Stratigraphy

Camp Stanley is underlain by approximately 1,000 feet of Cretaceous deposits made up of the Glen Rose and Travis Peak formations. Paleozoic schist underlies the Cretaceous deposits.

The Glen Rose represents a thick sequence of shallow marine deposits. It is subdivided into Upper and Lower units by a widespread stratigraphic marker known as the Corbula fossil bed (a bed of clam shells 3 to 5 millimeters in diameter). A gypsum bed is often associated with the contact. The Upper Glen Rose is comprised of alternating beds of limestone, marly limestone, blue shale, and occasional gypsum beds. The Lower Glen Rose consists of massive fossilferous limestone grading upward into thin beds of limestone, marl, and shale. Because of relatively thin soil cover at Camp Stanley, outcrops of the Glen Rose are common. At the B-20 site, the Glen Rose is 300+ feet thick.

The Travis Peak formation underlies the Glen Rose. The Travis Peak is subdivided into five units. In ascending order, these units are: Hosston Sand/Sligo Limestone, Hammet Shale, Cow Creek Limestone, and the Hensell Sand (locally known as the Bexar Shale). The Travis Peak is approximately 700 feet thick at Camp Stanley.

Hydrogeology

There are three aquifers in the Cretaceous-aged rock strata underneath CSSA: the upper, middle, and lower Trinity aquifers. Most production and monitoring wells at CSSA are completed in the middle Trinity aquifer. This aquifer is promoted by solution-enhanced permeable fractures and is the primary source of potable water at CSSA as well as most of the surrounding residential area's potable water needs. The middle Trinity aquifer encompasses the lower member of the Glen Rose, Bexar Shale, Cow Creek limestone, and Hammett shale formations and the upper part of the underlying Travis Peak formation. Water levels of the middle Trinity appear to be seasonally variable. Depths to water in CSSA Well 1, located about 500 feet northeast of the B-20 site and completed in the middle Trinity aquifer, ranged from approximately 219 feet below ground level in May 1994 to 277 feet below ground level in December 1994. This aquifer is described in detail in the "Hydrogeologic Report for Evaluation of Groundwater Contamination at Camp Stanley Storage Activity, Texas".

The upper Trinity aquifer is located within the upper member of the Glen Rose formation. The upper Glen Rose is exposed over much of the B-20 site. Recharge to the upper Trinity aquifer is from direct precipitation on the outcrop of the upper member of the Glen Rose formation and stream flow losses. Movement of groundwater in the upper

Trinity aquifer is restricted to lateral flow along bedding planes between marl and limestone, where dissolution has enhanced permeability of the limestone. During drilling at the B-20 site, groundwater was encountered in one of the soil borings (SB1) within a zone of interbedded marl and limestone. Occurrence of groundwater in this aquifer is sporadic and dependent on precipitation and secondary porosity features, indicating that beds within this aquifer are perhaps not hydraulically connected by avenues of vertical permeability. The upper Trinity aquifer is under water table conditions, it is generally of poor quality, and most wells achieve only low production

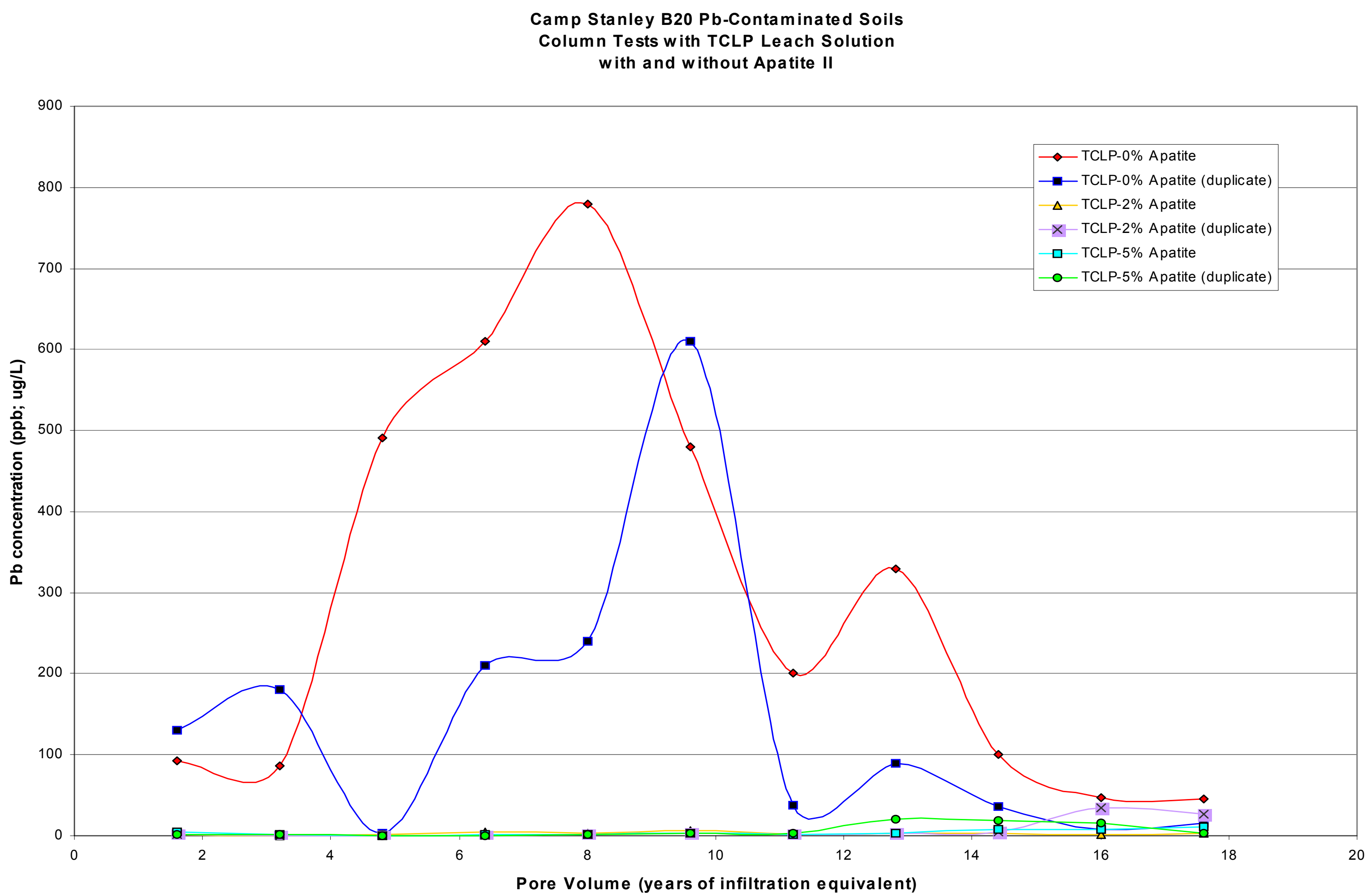
3.4 PRE-DEMONSTRATION TESTING AND ANALYSIS

As discussed previously, CSSA and Parsons performed extensive testing and evaluation of the SWMU B-20 site and its soils prior to the PIMS field demonstration. Table 3.5 lists concentrations of metals in the B-20 and B-24 soils collected in the field prior to any treatment. In addition to the prior testing of site demonstration soils, a feasibility study was conducted to determine the effect of Apatite II on soluble lead and its expected performance in the field. UFA Ventures performed the feasibility study, which also included a determination of lead concentrations that could leach from the site under various conditions, even if a worst case situation occurred with highly acidic infiltration over many years. The feasibility study consisted of a series of batch tests and soil column leaching tests (Figure 3.4) using various waters and amounts of Apatite II as described in the Demonstration Work Plan. The results indicated that 5% Apatite II mixed into soil would reduce leaching dramatically over decades. The study also indicated that the soils at B-20 would leach more lead than other soils and were a worst case scenario for the technology. These soils were used for the Phase I pilot-scale and Phase II full field scale demonstrations.

Table 3.5
Metal Concentrations in the B-20 and B-24 Soil Piles Designated for Remediation in this Demonstration

Site Soil	Metal	Concentration in ppm (mg/Kg)	Detection Limit
B-20	Arsenic	8.8	2.2
B-20	Antimony	19	11
B-20	Beryllium	0.95	0.44
B-20	Cadmium	4.2	1.1
B-20	Calcium	240,000	110
B-20	Chromium	28	2.2
B-20	Copper	120	2.2
B-20	Lead	2,100	2.2
B-20	Mercury	0.2	0.021
B-20	Nickel	15	8.8
B-20	Selenium	27	11
B-20	Silver	2.0	2.2
B-20	Thallium	2.2	2.2
B-20	Zinc	140	2.2
B-24	Arsenic	8.3	1.9
B-24	Antimony	9.6	9.6
B-24	Beryllium	0.94	0.38
B-24	Cadmium	4.5	0.96
B-24	Calcium	230,000	96
B-24	Chromium	26	1.9
B-24	Copper	210	1.9
B-24	Lead	360	1.9
B-24	Mercury	0.022	0.022
B-24	Nickel	15	7.7
B-24	Selenium	56	9.6
B-24	Silver	1.9	1.9
B-24	Thallium	1.9	1.9
B-24	Zinc	410	1.9

Figure 3.4 Column tests using the TCLP solutions, using soil with 5% Apatite II added and soil without Apatite II, in duplicate



3.5 TESTING AND EVALUATION PLAN

3.5.1 Demonstration Set-Up and Start-Up

Field activities began with site preparation activities. The Phase I site was located at the former SWMU B-10 location because of its proximity to utilities, e.g., water and electric, in the area. Figure 3.5 shows the location of SWMU B-10 within the inner containment of CSSA. Figure 3.6 shows the location of the Phase I demonstration efforts within SWMU B-10. The Phase I activities included a pilot-scale demonstration consisting of site grading, liner and leachate collection system construction, and emplacement of approximately 500 yd^3 of treated lead-contaminated soils. Figure 3.7 shows the Phase I construction detail for the pilot-scale demonstration efforts. In order to conserve water and prevent leachates from possibly percolating to the groundwater, a water (leachate collection) reuse system was installed to re-apply collected waters from the treatment area. This eliminated the permitting effort required by the TCEQ. To release waters to the State of Texas, a TPDES permit would have been required. This permitting process is cumbersome, time-consuming and expensive.

Phase I Site Construction

The water reuse system included a lined storage area which collected water that was then recirculated over the PIMS Phase I treatment area. It is estimated that as much as 1 million gallons of water was filtered through the treated soil to test efficacy of the PIMS treatment. Upon concurrence of CSSA and the regulators, the Phase II field-scale demonstration efforts treated the remaining soils at SWMU B-20. No permitting efforts were required because of the results of the Phase I efforts. Eventually, the Phase I treated soils were removed from the B-10 site for site restoration activities and the submittal to the TCEQ of B-10 site closed to background conditions (i.e., clean closure standards as specified by the state of Texas Risk Reduction Standard 1 criteria as specified in 30 TAC 335 subchapter S). The removed Phase I soils were placed back at the original generation site, SWMU B-20, effectively becoming part of Phase II and have been incorporated into the monitoring and assessment efforts for the Phase II field-scale demonstration efforts.


Sieving Operation at SWMU B-20

The Phase II demonstration was conducted with the sieved soils at SWMU B-20 (Figure 3.2). Previous analytical results used to characterize the soils are presented in Table 3.2. Figure 3.3 shows the sample location for the characterization samples analyzed for total CSSA metals within the sieved soil piles. Each of the remaining sifted soil piles were mixed with approximately 5% by weight

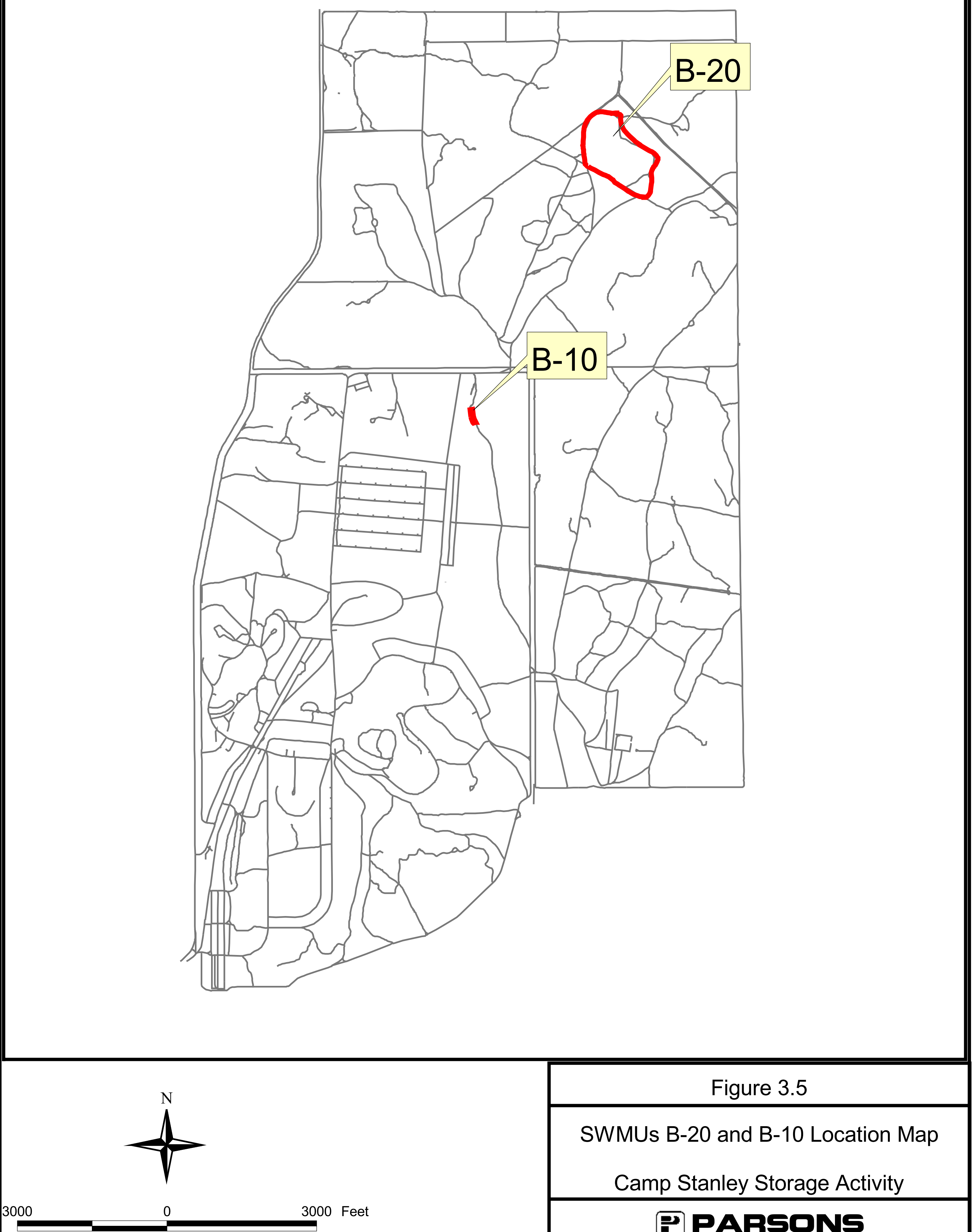


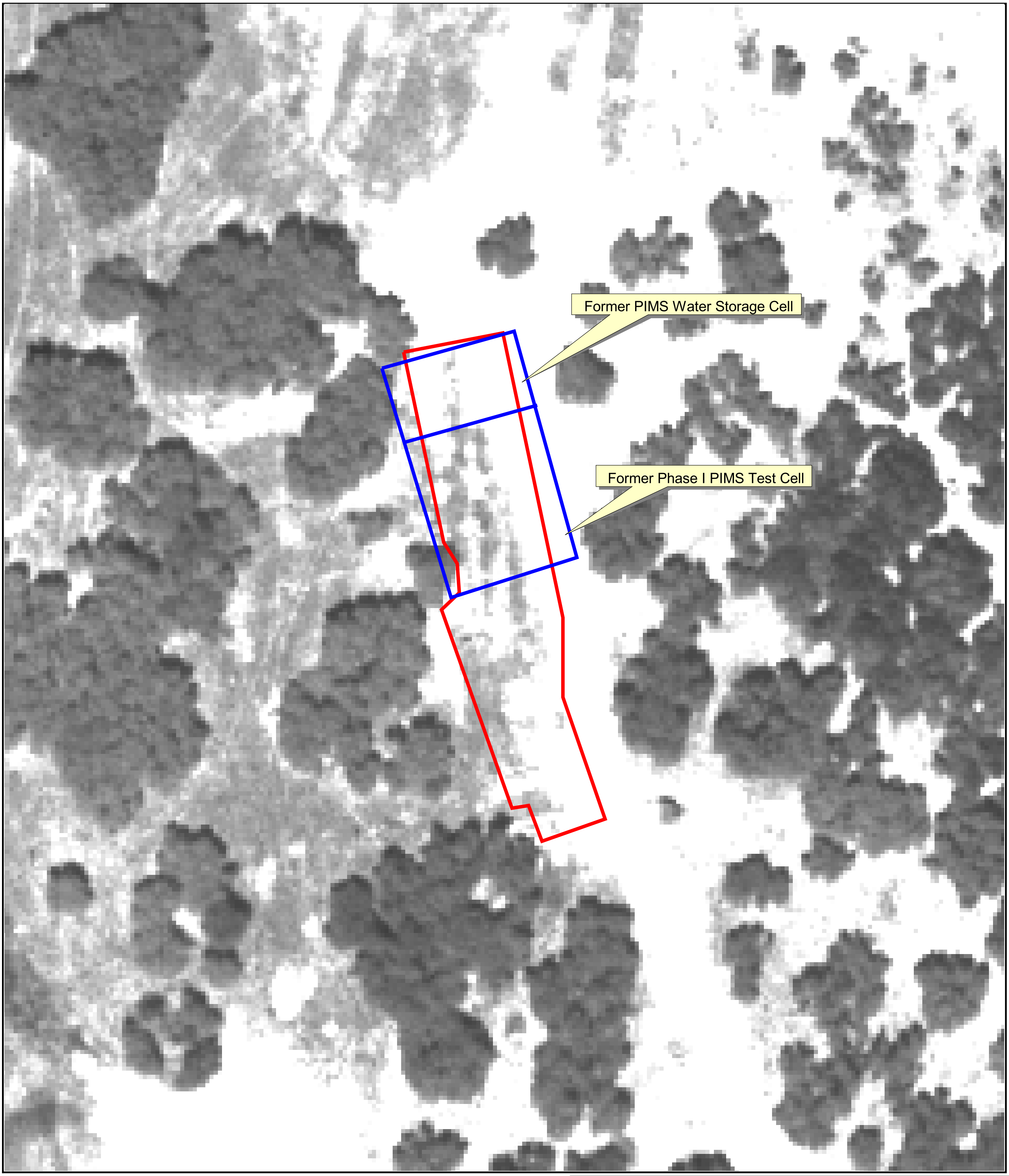
Figure 3.5

SWMUs B-20 and B-10 Location Map

Camp Stanley Storage Activity

PARSONS

j:\730\730396\rl-33closurerpt.apr



N

SWMU B-10 Boundary
PIMS Phase I Boundary

75 0 75 Feet

Due to different margins of error associated with the various methods utilized for data point collection, all sample locations are approximate.
For more information see the 2001 amendment to the Field Sampling Plan, Vol. 1-4 of the Environmental Encyclopedia.

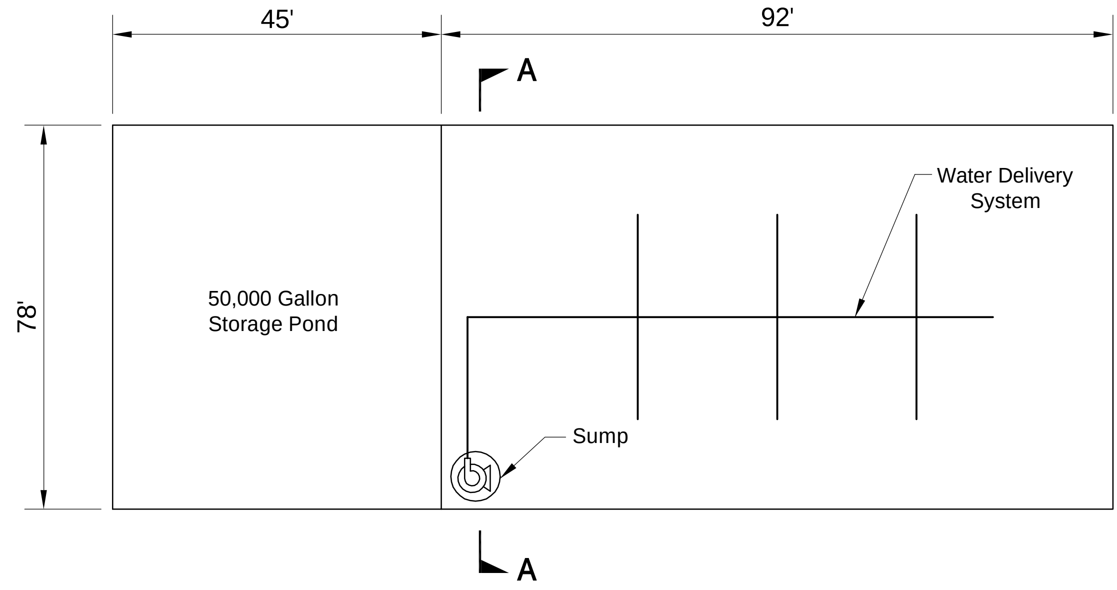
Figure 3.6

Phase I PIMS Location

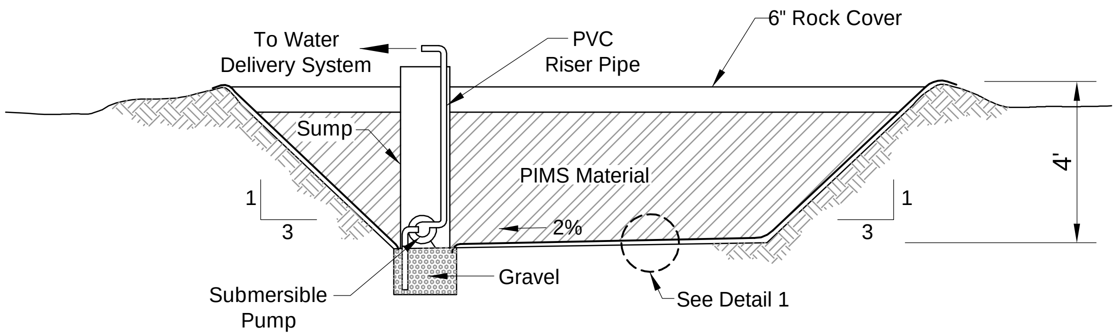
Camp Stanley Storage Activity

PARSONS

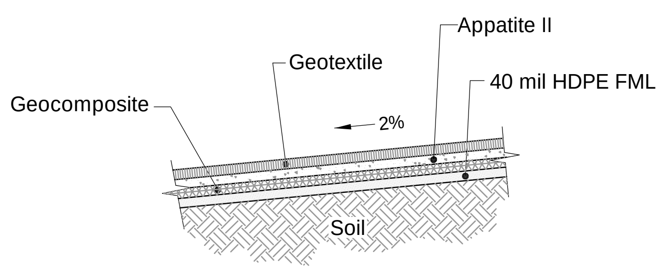
j:\736\736625\samplelocs.apr



Plan View



Section "A-A"



Detail 1

739249-01000 CSSA-PIMS.DWG

Note:
Dimensions are approximate.

Figure 3.7

Phase I
PIMS Treatment Unit Details

Camp Stanley Storage Activity

PARSONS

of Apatite II material and placed in a one-acre plot within the SWMU B-20 boundary (Figure 3.2). Lysimeters were installed into the one-acre Phase II demonstration site as well as the 20 ft x 20 ft unamended sieved soil plot used for evaluating baseline conditions of the treatment efforts. Figure 3.8 shows the location of the lysimeters and the sample locations for TCLP analyses of the Phase II demonstration within the Phase II demonstration site. Figure 3.9 shows the typical lysimeter construction detail for collecting leachate from the amended and unamended soil plots within SWMU B-20.

Phase II Lysimeter

The Sampling and Analysis Plan (SAP), Analytical Methods Supporting the Sampling Plan and Health and Safety Plan are provided in Appendices C, D, and F, respectively.

3.5.2 Period of Operation

The Phase 1 pilot-scale and the Phase II field-scale activities were initiated in May 2001 and October 2001, respectively. A chronology of events is shown in Table 3.4.

3.5.3 Amount/Treatment Rate of Material Treated

Approximately 500 yd^3 of contaminated soil were treated in the field over 2 weeks of actual construction and handling time for the Phase I efforts. The two-week effort included construction of a lined treatment cell with a leachate collection system designed for re-circulation of water to imitate a thirty-year rainfall event to the Phase 1 test site and water storage area.

Mixing Operations

During the Phase II efforts approximately 2,500 yd^3 of soil were treated with the Apatite II material over a one week period. The Phase II mixing efforts consisted of the use of a front-end loader to effectively mix approximately 5% by weight of Apatite II material within the lead impacted soil from the SWMU B-20 site. A small portion of the remaining soils, approximately 10 yd^3 was left untreated for use as initial background conditions and further remedial technology demonstration activities, as necessary. An average treatment rate of 500 yd^3/day of site soils were amended with the Apatite II material was observed during the demonstration activities.

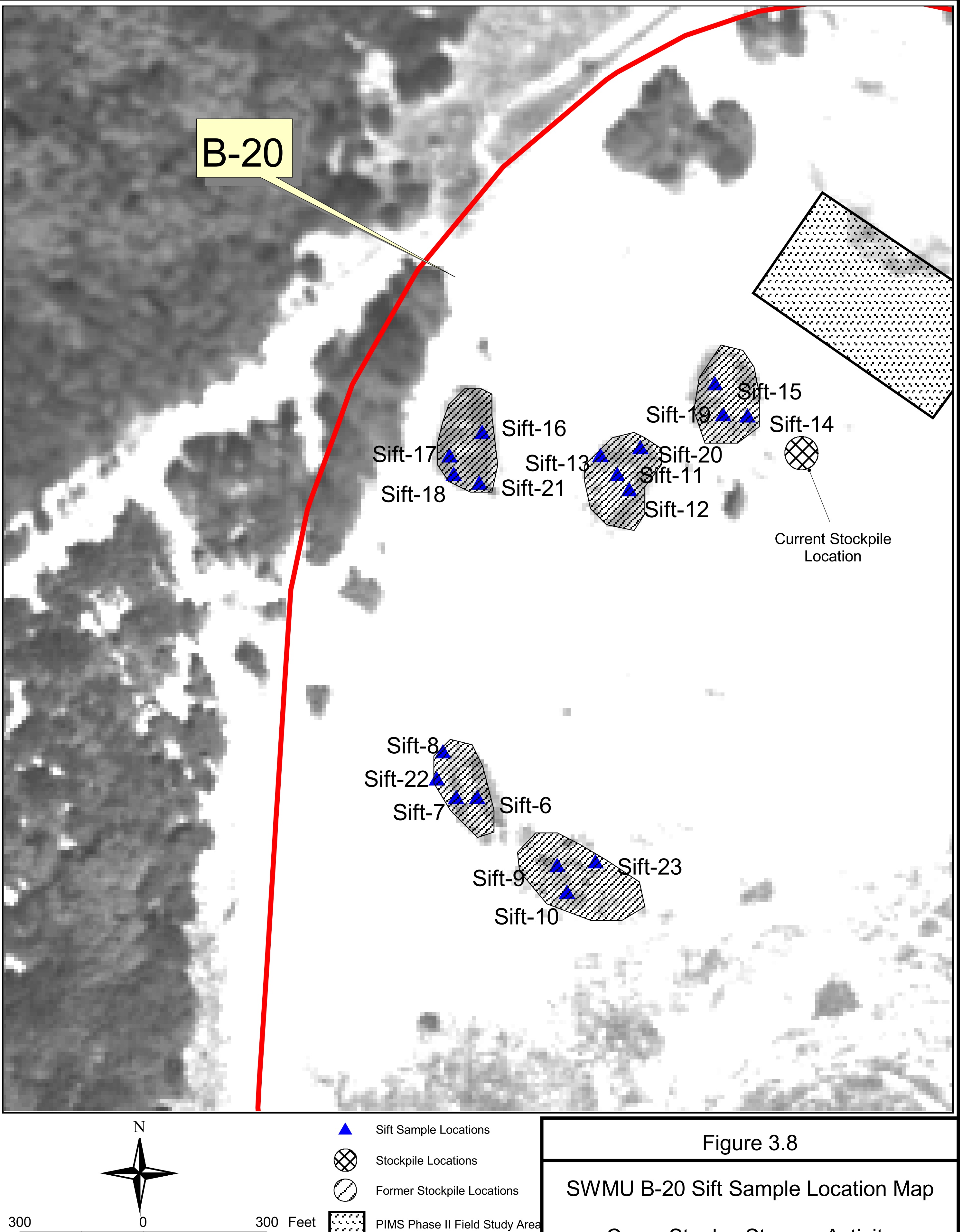


Figure 3.8

SWMU B-20 Sift Sample Location Map

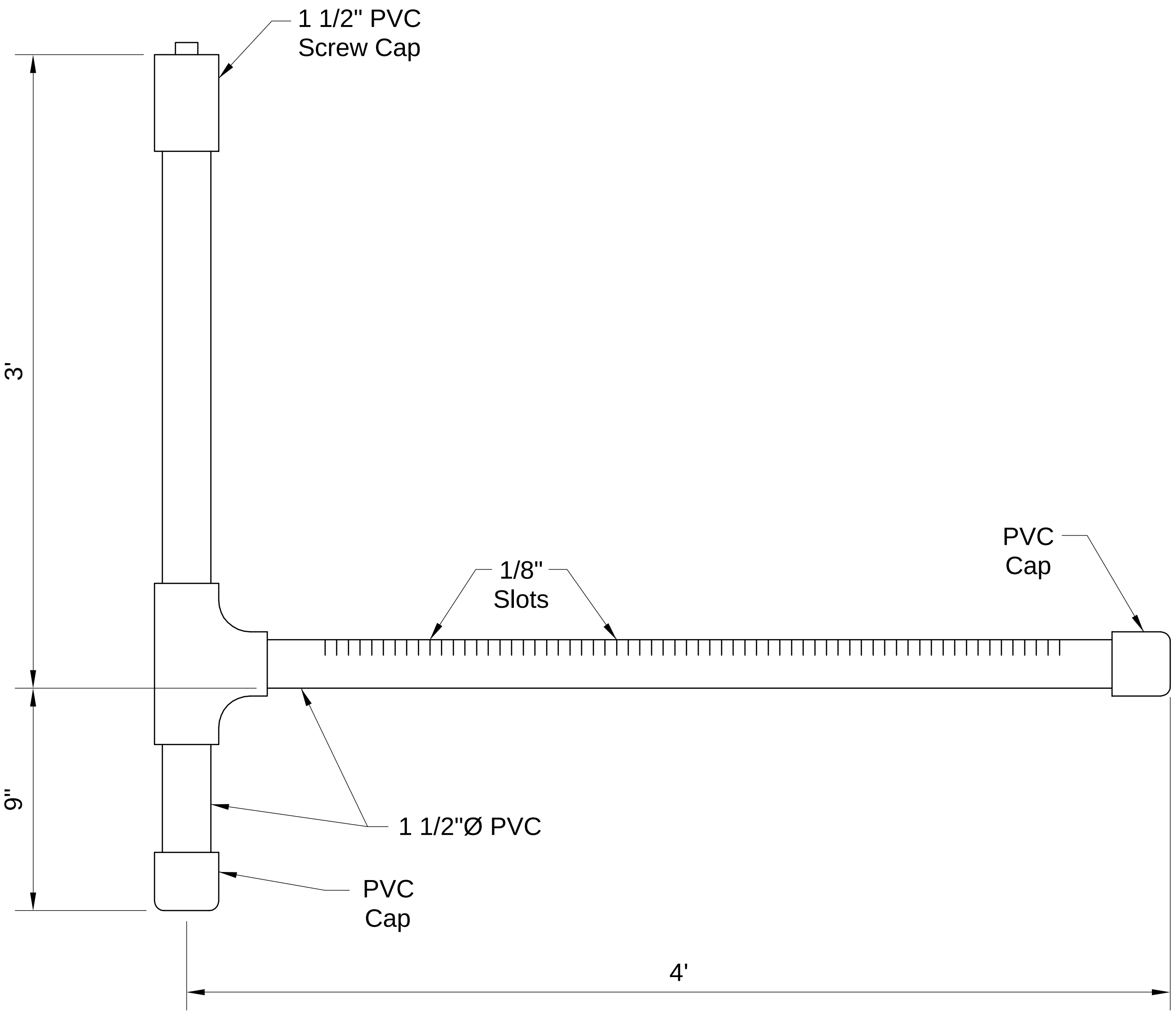
Camp Stanley Storage Activity

PARSONS

Due to different margins of error associated with the various methods utilized for data point collection, all sample locations are approximate. For more information see the 2001 amendment to the Field Sampling Plan, Vol. 1-4 of the Environmental Encyclopedia.

j:\730\730396\rl-33closurerpt.apr

739249 CSSA-LYS.DWG



Not to Scale

Figure 3.9

Phase II
Typical Lysimeter Detail

CSSA B-20

PARSONS

3.5.4 Residuals Handling

During the demonstration activities, only the water used during the Phase I efforts generated residuals which required special handling. As noted, water passing through the treatment zone cannot be released to the surface without obtaining a TPDES permit modification. The water used during the phase I demonstration was collected and recycled. This allowed for water conservation, as the region is prone to drought conditions during the summer months.

When the Phase I demonstration efforts were completed, the water was collected and used as synthetic rainfall for the Phase II efforts during August of 2002. It is not anticipated that any residual handling will be required during the use of this technology.

3.5.5 Operating Parameters for the Technology

The operating parameters for the demonstration included the construction of a lined treatment area (only during Phase I, normally not required for this treatment technology) and the application (mixing) of Apatite II into the contaminated soil (mixing operations). As discussed previously, the Phase I observations provided data showing that leachates from Apatite II-treated soils were below the MCL for lead, which indicated that there are minimal concerns from surface water run-off and leachate generated from the treated soils.

Mixing efforts were conducted as batch treatments. However it is envisioned that continuous mixing efforts could be utilized if a large amount of soil is expected to be treated. This could be accomplished with the use of a pug mill or other flow-through mixing units. However, for our demonstration efforts, the use of non-specialized equipment (front-end loader and a maintainer) was used effectively to mix approximately 3,000 yd^3 of lead contaminated soil at an approximate rate of 500 yd^3 per day. The batch process was accomplished for this effort in 10 yd^3 lots with a 5% by weight mixture of Apatite II material added to the contaminated soil. The soil was mixed with a maintainer which folded the Apatite II material within the soil matrix in passes along a designated area for treatment. The front-end loader placed the soil and Apatite II material within the designated area, and upon completion, removed the treated material to a separated designated location for staging before final emplacement. Labor requirement included two heavy equipment operators, a site supervisor, and a health and safety officer to monitor safety conditions of the operations.

Upon completion of the mixing operations, samples from the treated soils were gathered for analysis by TCLP, as provided in Appendix A.

3.5.6 Experimental Design

The experimental design is for a cleanup remediation technology. As explained earlier, the effort included treatment of approximately 3,000 yd^3 of lead-contaminated soils within the SWMU B-20 area. The soils had approximately 5% by weight of Apatite

II material added and were mixed sufficiently in 10 yd^3 batches. The treated soils were then transported to the one-acre area selected for the demonstration for observations of efficacy. The field emplacement process was accomplished at an application rate of approximately 500 yd^3 a day using a front-end loader and a maintainer. Detailed construction drawings and specifications were developed for subcontractor bid costs. These detailed construction drawings and specifications are provided in Appendix E as part of the QA efforts for the project. All analytical and sampling methods that were used in supporting the experimental design are provided in Appendix B, the CSSA project related Sampling and Analysis Plan (included as Appendix C), and associated Quality Assurance Project Plan (QAPP) (included as Appendix E).

3.5.7 Sampling Plan

For this project, soil and water samples were collected for chemical analysis. The analysis and sampling efforts used during the demonstration activities have recognized standard procedures, such as the USEPA Solid Waste (SW) 846 method, while others allow some latitude in techniques, such as the use of lysimeters for collection of leachate samples within the Phase II demonstration efforts. The equipment required for the various activities ranges in complexity from tape measures to peristaltic pump instruments. Parsons developed field procedures to ensure that field activities at the study site were performed in a consistent manner to meet QA/QC objectives. Generally, soil characterization samples were collected as a one time sampling event throughout the demonstration project. Monitoring samples were collected on a quarterly schedule, weather permitting.

A Sampling and Analysis Plan (SAP) for the collection of analytical data and sampling methods that were employed at the site for this demonstration is located in a separate document developed for the CSSA environmental program and included as Appendix C of this report. Sampling and analysis followed the outlined procedures for collection of soils, (SAP section 2.1.1) and water (leachate) (SAP section 2.1.7) during the operation and monitoring of the field demonstration effort. The sampling of sieved soils was accomplished by randomly selecting sample locations in an unbiased manner. Sample locations were randomly selected based on a reference point as described in Section 2.6 of the SAP. The sample location and depth was then identified using a random number generator.

Phase II Sampling

The demonstration efforts included total metal analyses including lead by SW 846 method (SW)7421; barium, chromium, copper, nickel, and zinc by SW6010B; arsenic by SW7060A; cadmium by SW 7131A; and mercury by SW7471A. In addition to the total

metal analyses, TCLP extraction method SW1311 and SPLP extraction method SW1312 was used during this demonstration.

All analytical methods are specified within the SAP and associated Quality Assurance Project Plan (QAPP) and followed USEPA guidance specified in SW-846 Analytical Methods. Additionally, as part of the SAP a field sampling plan is included to provide standard procedures for the collection of all sample media types. The SAP is located in Appendix C. The QAPP is located in Appendix E. All samples were collected by Parsons, Inc. employees and analyzed by Agricultural & Priority Pollutants Laboratory, Inc. (APPL) located in Fresno, California. Sample media included soil and water (leachate) samples.

In general, leachate samples were collected as grab samples employing the use of a peristaltic pump with the use of a 0.45 micron filter. Samples were collected into one liter amber jars for further filtering efforts, if necessary, or in 250 mL plastic containers which contained pre-measured nitric acid to preserve the sample. Some of the leachate samples were further filtered using a syringe with 0.1 micron filter. The sample was pre-filtered using a 0.45 micron filter and placed into a one liter amber jar. There are no known site characteristics or physical characteristics of the site which may have affected the sampling equipment during monitoring of the demonstration. The holding times for samples are specified in Table 2.2 of the SAP for aqueous samples.

Soil samples were collected, as denoted in SAP section 2.1.1, using pre-cleaned stainless-steel sampling spoons and stainless steel bowls for compositing, as necessary. The samples were then placed into 8 oz. jars with the holding times specified in Table 2.1 of the SAP. Sample handling is described in section 2.2 of the SAP. Section 2.3 and Section 2.4 of the SAP describe the sample custody and quality control sampling for the demonstration effort, respectively. Figure 3.9 shows the location of the Phase II lysimeters and soil characterization samples collected for determining the efficacy of the demonstration. The field QA/QC program, included as section 4 of the SAP, describes the steps taken to ensure that sample handling precluded the possibility of contamination, deterioration, or damage and includes corrective actions required if sampling efforts are out of anticipated control limits. Additionally, all leachate and soil samples were identified using a unique sample designation on the sample container and in the field record book. Soil and leachate sample identification details are noted in their respective summary tables. Sample splits used in the *in vitro* tests for bioaccessibility are described in the SOP located in Appendix D. No composite samples were used for the *in vitro* testing or for other analyses.

Section 4 of the QAPP (Appendix E) used for this demonstration project specifies the data quality parameters employed to ensure precision (QAPP section 4.2.1), accuracy (QAPP section 4.2.2), representativeness (QAPP section 4.2.3), completeness (QAPP section 4.2.4), and comparability (QAPP section 4.2.5). Equations for calculating data quality are specified in QAPP table 4.2.1-1. The initial and continuing calibration procedures for the analytical instrument and the laboratory control sampling are further

discussed in QAPP section 4.3.3. Additionally, the QAPP includes the required reporting limits for each of the analytes included for this demonstration.

3.5.8 Demobilization

Upon completion of the field demonstration project, the Phase I site demonstration area was returned to its original condition. The treated soils were removed from the lined area and the liner and leachate collection system dismantled. The Phase I treated soils were taken back to the originating site and located alongside the Phase II treated soils thus becoming part of the Phase II demo and the IMCA.

3.6 SELECTION OF ANALYTICAL/TESTING METHODS

Each sample collected for soil and water were analyzed for lead using USEPA SW-846 method SW7421 or SW7420. Additional parameters analyzed included the CSSA metals as determined through site characterization activities prior to this demonstration. These metals include arsenic (SW7060A), cadmium (SW7131A), mercury (SW7471A), and barium, chromium, copper, nickel, and zinc analyzed by SW6010B. The SAP and the installation QAPP are located in Appendices C and E, respectively. These plans denote how the samples were gathered, analyzed, and the QA/QC samples that were collected.

3.7 SELECTION OF ANALYTICAL/TESTING LABORATORY

APPL performed the analytical analyses for this demonstration effort. APPL is located at 4203 West Swift, Fresno, California. 93722, Diane Anderson is the point of contact. Phone number is 559-275-2175 and facsimile number is 559-275-4422.

SECTION 4
PERFORMANCE ASSESSMENT

4.1 PERFORMANCE CRITERIA

Performance criteria that were used to evaluate performance of the PIMS remedial technology are presented in Table 4.1. The general performance criteria used to evaluate performance of the innovative technology include reduction in contaminant mobility, ease of use, etc., and are shown in Table 4.2.

Table 4.1
Performance Criteria

Performance Criteria	Description	Primary or Secondary
Contaminant Reduction	This technology reduces the mobility of lead into surface water or groundwater.	*Primary*
Contaminant Mobility	Pb mobility was decreased as a result of this technology	*Primary*
Hazardous Material	The demonstration efforts did not use any hazardous materials.	*Secondary*
Process Waste	There was no process waste generated during the field scale (Phase II) demonstration efforts. During Phase I demonstration efforts leachate generated was collected and used as synthetic rainfall.	*Secondary*
Factors Affecting Technology Performance	Technology performance is unaffected by almost any operating condition including flow rate, feed rate, through-put, temperature, etc. Soil type, particle size distribution, GW pH, dissolved oxygen, and other contaminants also have little or no affect on the technology performance., even under unusual conditions. However it is recognized that frozen tundra, large boulders or debris are not conducive to the mixing requirements for this technology.	*Primary*

Performance Criteria	Description	Primary or Secondary
Reliability	This technology has no reliability problems. Potential breakdown of the emplacement equipment may cause delays, but the performance will not be affected. Also there is no sensitivity to environmental conditions, the emplacement can be done at any time and conditions will only affect the comfort of the field personnel.	*Secondary*
Ease of Use	The actual number of personnel in the field was four. This technology involves ordinary use of earth-moving equipment such as backhoe/loader, maintainer, and shovel. No special training is required. OSHA health and safety training is required as for any hazardous waste site, i.e., 40-hour HAZWPR.	*Primary*
Versatility	This technology can be used for other applications, e.g., permeable reactive barrier walls or treatment tanks, and it can be used at almost any other location. The technology can be adapted easily to other conditions and sites.	*Secondary*
Maintenance	No maintenance is anticipated for use of this technology. Only monitoring may be required.	*Primary*
Scale-Up Constraints	There are no issues of concern with scaling up the technology for full implementation, only using more Apatite II over a larger area.	*Secondary*

Table 4.2 Expected Performance and Performance Confirmation Methods

Performance Criteria	Expected Performance Metric (pre demo)	Performance Confirmation Method*	Actual (post demo)
PRIMARY CRITERIA (Performance Objectives) (Qualitative)			
Contaminant mobility	The contaminant mobility is expected to be reduced such that the leachable lead available from the treated soils meet the groundwater MCL	Analysis of generated leachate by USEPA SW-846 methods.	The contaminant mobility was reduced as expected.
Ease of Use	This technology only utilizes typical construction type equipment for mixing and emplacement of the treated soils.	Experience from demonstration operations	Equipment included use of a backhoe/loader, maintainer and shovel.
PRIMARY CRITERIA (Performance Objectives) (Quantitative)			
Feed Stream - Contaminant Concentration	10 cubic yard batch process with expected lead levels greater than 2,000 ppm.	USEPA SW-846 method 6010B.	Approximately 500 cubic yards/day treated during demonstration treatment efforts.
Target Contaminant - Regulatory Standard	Reduce leachable lead from soil to less that 15 ppb Secondary goal to reduce leachable lead to below state of Texas Class 1 non-hazardous waste criteria of 1.5 ppm	USEPA SW-846 method 7421. USEPA SW-846 method 1311/6010B.	Observations concluded that leachate generated from the site ranges from 2 to 7 ppb, well below the MCL for lead (15 ppb) and reduced the leachable lead from the soil matrix to State of Texas Class 2 non-hazardous waste criteria. Bioaccessibility analysis used in evaluating risk to adult humans indicated a reduction in bioavailability and a preliminary remediation goal of 2,330 mg/kg which was met at the IMCA at SWMU B-20.
Hazardous Materials - Eliminated - Generated	None None	Not Applicable Not Applicable	
Reliability	None	Not Applicable	
Process Waste			Leachates from the Phase 1

Performance Criteria	Expected Performance Metric (pre demo)	Performance Confirmation Method*	Actual (post demo)
- Generated	None	Observation	demonstration efforts were generated.
Factors Affecting Performance - Throughput - Media Size	 - No limit - Large rocks may slow throughput	 Analysis at high flow rate Soil sieving may be applicable	The demonstration treatment rate was 500 yd^3 per day. The demonstration was performed on site soil which had previously been sieved for UXO removal actions.
SECONDARY PERFORMANCE CRITERIA (Qualitative)			
Reliability	No breakdowns	Record keeping	No breakdowns within the treatment application. The monitoring phase experienced minor leachate collection problems as a result of sampling equipment failure.
Safety - Hazards - Protective Clothing	 Dust Modified Level D PPE	Experience from demonstration operation Personnel monitoring	All field efforts were conducted in Modified Level D PPE and no significant dust was noted as being generated.
Versatility - Intermittent Operation - Other Applications	 Yes Yes, may be applicable for other contaminant (e.g., chromium, cadmium, etc.)	 Experience from demonstration operation USEPA SW-846 method 6010B.	Treatment rates from the Phase 1 and Phase II efforts were approximately the same. The mixing operations could be intermittent as necessary due to operational or weather constraints. Other metals were monitored with copper and zinc showing significant reductions in soluble concentrations within treated vs. non-treated leachate sample analysis.
Maintenance - Required	 None	Experience from demonstration operation	Field treatment demonstration efforts required no efforts for maintenance. However, monitoring efforts did require leachate collection systems maintenance.
Scale-Up Constraints - Flow Rate -Contaminant Concentration	 Largest batch unit available Toxicity levels to classify waste.	Monitor during demonstration operation USEPA SW-846 method 1311/6010B.	Through field observations there do not seem to be any scale-up constraints with application of this technology.

* Refer to Appendix B or Appendix D for further details

4.2 PERFORMANCE CONFIRMATION METHODS

Effectiveness of the demonstration was evaluated by monitoring lead and other CSSA metal concentrations in the leachate. Leachate samples were collected using standard reproducible practices to ensure that analytical data are comparable. To measure the efficiency of the PIMS remedial technology quarterly monitoring samples were collected from both Phase I and Phase II site demonstration efforts. Analytical data was generated from APPL, Inc. and has been audited twice during the performance period by Parsons and AFCEE representatives for the CSSA program. This ensures that reliable data is generated and can be used with confidence in making remedial/closure decisions or efficacy determinations.

A successful demonstration is attained when the lead or metal concentrations within the leachate are reduced to below the MCL and/or groundwater protective concentration limits for that metal as specified by the State of Texas Risk Reduction Program codified in 30 Texas Administrative Code (TAC) 350. A secondary criterion exists for waste treatment efforts. This criterion is established by the regulators for disposal of the contaminated media within a landfill. These criteria (treatment) are specified in 40 CFR 268 land disposal restrictions for hazardous waste as well as 30 TAC Chapter 335 Subchapter R (waste classification) for non-hazardous waste. Additionally, in order to address potential risk of bioavailable lead to human health, samples of the soil were collected and bioaccessibility tests were performed for determining preliminary remediation goals (PRG). A report of the findings on the bioaccessibility of site demonstration soils is provided in Appendix D. This data allows for an evaluation of the potential closure options for the demonstration site.

4.3 DATA ANALYSIS, INTERPRETATION, AND EVALUATION

4.3.1 Correlation between operating parameters and required performance specifications

Operating parameters specified for this demonstration project involved mixing of the appropriate 5% by weight of Apatite II within the soil matrix. This was accomplished using a backhoe/front-end loader and a maintainer in 10 yd^3 batches.

4.3.2 How optimum operating conditions identified were confirmed through subsequent process operation

The use of a 5% by weight mixture of Apatite II was identified in the benchscale testing which indicated that a 2% by weight mixture of Apatite II would most likely meet our goals. However, to ensure that appropriate mixing could be accomplished with normal industrial equipment the 5% by weight mixture was determined to be appropriate for this demonstration effort.

4.3.3 Data reduction, validation and reporting

A summary of monitoring results of both the Phase I pilot scale demonstration and the Phase II full-scale demonstration are presented in Tables 4.3 and 4.4. Table 4.3 shows the results of TCLP analyses for the amended soils. Results indicated that the amended soils meet State of Texas class 2 non-hazardous waste classification criteria of 1.5 mg/L (per 30 TAC chapter 335 subchapter R) with an average concentration of 0.46 mg/L. Table 4.4 shows the results of analyses for leachate generated from the demonstration efforts. Results range from 347 ppb to 0.8 ppb. The 347 ppb result was the first sample taken from the Phase I demonstrations efforts and was not filtered to remove the particulate from the matrix. The remaining samples were filtered with either a 0.45 micron filter or 0.1 micron filter to remove the suspended particles within the leachate. The average leachate concentration from the demonstration efforts was 6.5 ppb well below the 15 ppb standard for drinking water. Figure 4.1 graphically presents all demonstration analytical results on a lognormal distribution and includes total soil concentrations, TCLP concentrations, and leachate concentrations from the demonstration site. Results indicate that a significant reduction of soluble lead within leachate generated from amended soils as compared to unamended soils.

The arithmetic mean was calculated for lead levels in soil and leachate concentrations and is also denoted on Figure 4.1. The soil arithmetic mean was calculated for lead using site characterization data with the two upper and one lower concentration removed from the subset. The data removed from the averaging calculations were considered outliers of the normal distribution of lead concentrations for the soil due to their abnormally high lead concentrations or abnormally low lead concentrations which represent background conditions. It is believed that the two highest lead concentration values (40,509 mg/kg, and 23,550 mg/kg) are likely lead particulates greater that 2 mm (i.e.; “lead nuggets”) and are not representative of the average particulate lead size or the more mobile lead forms such as lead oxide, or lead carbonate.

it is important to determine potential exposure-point concentrations which are then used in evaluating risk to human health and are criteria to which preliminary remediation goals are compared. The exposure-point concentrations are calculated using the 95-percent upper confidence limit (UCL) on the mean. The standard UCL formula (Rice, 1995) is applied when the data adequately fit a normal distribution. Using the Shapiro-Wilk test to the untransfomed data, the soils data were determined to fit parametric distribution. Therefore, to calculate the 95-percent UCL for normally distributed data, the arithmetic mean and standard deviation of the data are calculated, and the on-tailed t-statistics are determined from Gilbert (1987). The 95-percent UCL is calculated by using the equation:

$$95 - percent\ UCL = \overline{x} + t\left(\frac{s}{\sqrt{n}}\right)$$

where:

$\overline{x}$ = arithmetic mean

s = standard deviation

t = one-tailed Student's-t statistic (Gilbert, 1987); and

n = number of samples

The UCL for the soil used in the demonstration efforts was calculated as 1,720.5 mg/kg, with an arithmetic mean of 1,157 mg/kg, and a standard deviation of 1,377.85.

Table 4.3 TCLP Results for Amended Soils

	EPA METHOD / CONCENTRATION SW6010B (mg/l)	
DATE	**SAMPLE ID**	**Lead**
06/21/01	PIMS-T-0601	0.2361
10/10/01	B20-PIMS-1	0.2730
10/10/01	B20-PIMS-2	0.5066
10/10/01	B20-PIMS-3	0.8085
10/10/01	B20-PIMS-4	1.2311
10/10/01	B20-PIMS-5	0.4684
10/10/01	B20-PIMS-6	0.3115
10/10/01	B20-PIMS-7	0.1706
10/10/01	B20-PIMS-8	0.1195

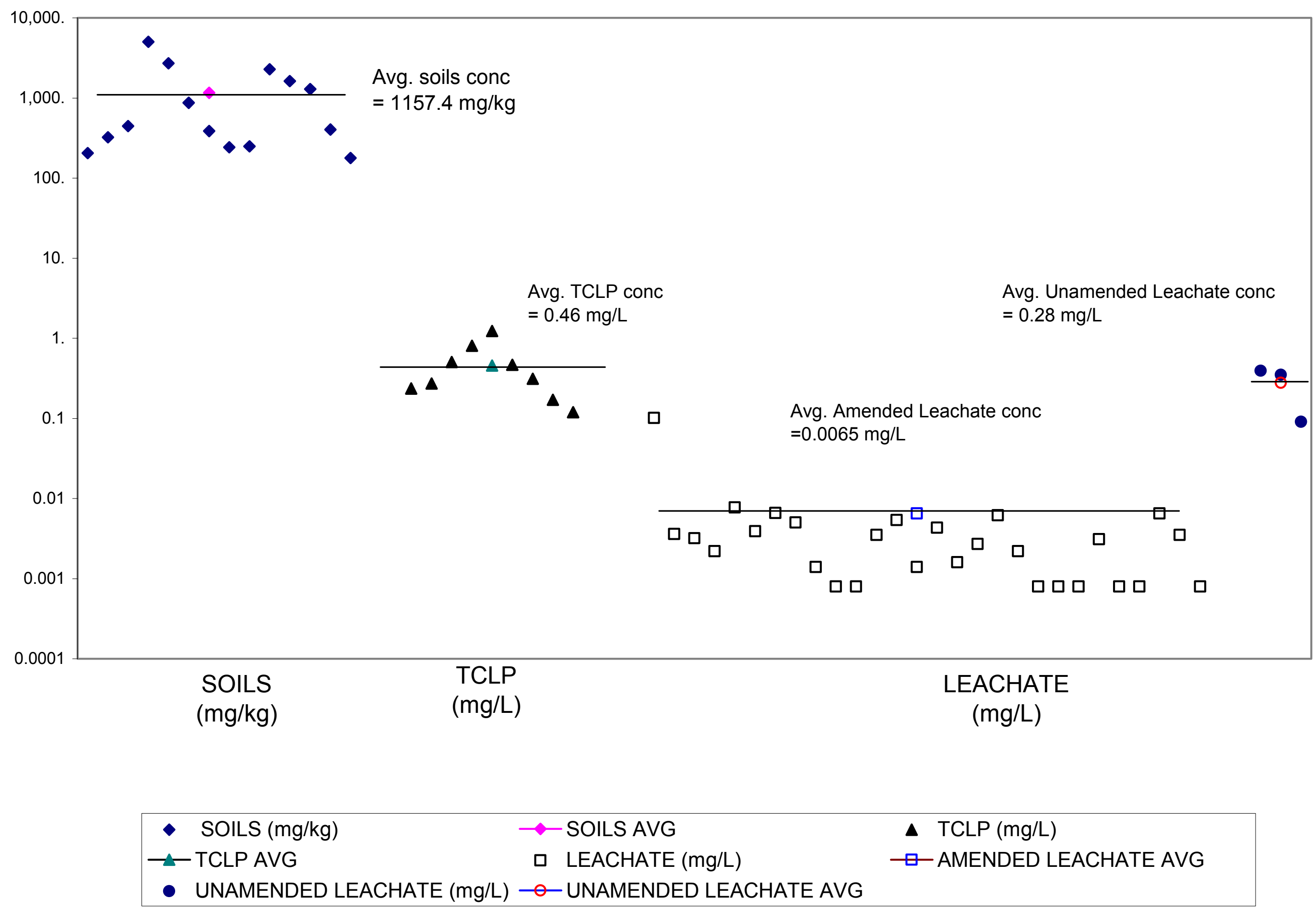
Table 4.4 Leachate Monitoring Results

		EPA METHOD / CONCENTRATION								
		SW7421 (mg/L)	SW6010B (mg/L)					SW7060A (mg/L)	SW7131A (mg/L)	SW7471A (mg/L)
DATE	**Sample ID**	**Lead**	**Barium**	**Chromium**	**Copper**	**Nickel**	**Zinc**	**Arsenic**	**Cadmium**	**Mercury**
Phase 1 Data										
7/9/2001	PIMS 1	0.3473								
8/14/2001	PIMS 2.45	0.1012								
	PIMS 2.1	0.0036								
10/23/2001	PIMS Leachate	0.0032								
12/19/2001	PIMS 3.45	0.0022								
2/27/2002	PIMS 4.45	0.0077								
	PIMS 4.1	0.0039								
Phase 2 Data										
4/11/2002	B-20-L2-1.45	0.0066								
	B20-L3-1.45	0.0050								
	B20-L3-1.10	0.0014								
6/30/2002	B20-L1-2.45	0.0008	1.9684	0.0030	0.0690	0.0150	0.0500	0.0050	0.0001	0.0001
	B20-L2-2.45	0.0008	1.2520	0.0010	0.0450	0.0080	0.0340	0.0091	0.0003	0.0001
7/10/2002	B20-L2-3.45	0.0035	4.1442	0.0010	0.1220	0.0200	0.1350	0.0076	0.0002	0.0002
	B20-L3-3.45	0.0054	0.6227	0.0010	0.0310	0.0050	0.0340	0.0124	0.0003	0.0001
8/21/2002	B20-L1-4.1	0.0014	0.4162	0.0010	0.0390	0.0060	0.0210	0.0010	0.0002	
	B20-L2-4.1	0.0043	0.0463	0.0020	0.0110	0.0030	0.0330	0.0013	0.0003	
	B20-L3-4.1	0.0016	0.3076	0.0010	0.0260	0.0050	0.0190	0.0024	0.0001	
10/26/2002	B20-L1-5.45	0.0027								
	B20-L2-5.45	0.0062								
	B20-L3-5.45	0.0022								
	B20-L4-5.45	0.3937	15.5902	0.0040	0.0810	0.0050	0.0960	0.0008	0.0003	0.0001
12/21/2002	B20-L1-6.45	0.0008	1.7758	0.0010	0.0380	0.0070	0.0310	0.0008	0.0001	
	B20-L1-6.1	0.0008	1.7973	0.0030	0.0390	0.0080	0.0280	0.0008	0.0001	
	B20-L2-6.45	0.0008	0.6582	0.0040	0.0380	0.0070	0.0310	0.0008	0.0001	
	B20-L2-6.1	0.0031	0.5903	0.0010	0.0360	0.0060	0.0300	0.0008	0.0003	
	B20-L3-6.45	0.0008	0.5548	0.0010	0.0190	0.0030	0.0200	0.0008	0.0001	
	B20-L3-6.1	0.0008	0.5337	0.0010	0.0190	0.0030	0.0210	0.0008	0.0001	
	B20-L4-6.45	0.3512	11.0650	0.0010	0.0770	0.0040	0.0460	0.0008	0.0001	
	B20-L4-6.1	0.0906	11.4710	0.0020	0.0740	0.0080	0.0590	0.0008	0.0002	
4/10/2003	B20-L1-7.45	0.0065								
	B20-L2-7.45	0.0035								
	B20-L3-7.45	0.0008								

Phase 1 notes:
PIMS refers to the Phase 1 efforts
1 through 4 refers to the sampling event
.1 or .45 is the filter size (microns) used to filter the collected leachate before analysis. If no decimal the a filter was not used.
Leachate refers to a sample collected from the water used during the demonstration

Phase 2 notes:
B20 is the Phase 2 location
L = Lysimeter
L1, L2, & L3 are lysimeters installed in the one-acre amended soil plot
L4 is the lysimeter in the 20' x 20' unamended soil plot
-1 thorugh -7 refers to the sampling event
.1 or .45 is the filter size (microns) used to filter the collected leachate before analysis.

Figure 4.1 Lognormal Distribution of Analytical Data



4.3.4 Risk Assessment

The results of a site-specific human health risk assessment provide estimates of potential risks and/or hazards to human health associated with exposure to site-related chemicals. In the case of SWMU B-20 at the Camp Stanley Storage Activity (CSSA), lead is identified as the chemical of concern, thus a risk assessment for determining risk-based remediation goals, otherwise know as preliminary remediation goals (PRGs) using applicable U.S. Environmental Protection Agency (USEPA) guidance, is appropriate to assess risk/hazards associated with potential exposure to lead.

The expected future uses and activities for SWMU B-20 are not yet finalized, but are unlikely to include a residential use in the next 30 years. While children are most at risk from lead toxicity in residential areas, adults are the primary population at risk in non-residential areas. For example, adult workers may be exposed to lead in soil and dust while performing site maintenance, site operations (e.g., drilling/monitoring wells), or other tasks. Therefore, it is important to estimate the potential risk to adults. The USEPA has developed screening criteria to estimate the PRGs of lead in soil for adults, where the estimated blood lead concentrations will not exceed the level of concern, typically 10 µg/dL (US EPA 2003). The PRGs in the USEPA model are based on a number of factors that can be changed from default parameters based on high-quality site-specific information. The default values of the USEPA Adult Lead Model should be used in situations where high-quality site-specific data are not available.

The USEPA Adult Lead Model is based on a simplified representation of lead biokinetics to predict quasi-steady-state blood lead concentrations among adults with relatively steady patterns of site exposure. The USEPA believes the use of the Adult Lead Model is useful in assessing potential risks associated with lead exposures at most sites where places of employment are (or will be) located on lead-contaminated soils. Therefore, the Adult Lead Model is applicable to SWMU B-20 at the CSSA. However, in order to use the Adult Lead Model for SWMU B-20 at the CSSA, we must have a way to relate the *in vitro* bioaccessibility test results we have obtained for SWMU B-20 at the CSSA to adult bioavailability in order to have the appropriate input factor for use in the Adult Lead Model risk assessment.

It should be noted that *in vivo* direct tests and *in vitro* indirect tests of bioavailability are, by convention, given as percents of the total lead in the system. Therefore, it is difficult to compare results among different tests, systems with different lead contents, and systems treated with different amendments. Given that limitation, comparisons should be done between systems that are as similar as possible, e.g., similar total lead contents, similar particle size fractions, similar treatment modes, and similar tests.

To examine the effects of soil remediation on lead bioavailability, soils at SWMU B-20 at the CSSA were amended with PIMS as described in Section 3 of this report. Eleven samples (analyzed in triplicates), gathered from the unamended and amended soils at SWMU B-20 at CSSA, were analyzed by an *in vitro* test method developed by

Ruby et al. (1993, 1996, and 1999) and performed by Exponent. These tests determine the bioaccessibility value for lead in soils. Discussion and results of the *in vitro* analysis for the CSSA study soils are provided in Appendix D.

The results of the US EPA risk assessment model are presented in this report, with possible implications for soil lead cleanup using PIMS. It should be noted that application of the *in vitro* test to estimate reductions in lead bioavailability from phosphate amended soils is a screening level tool, and that actual *in vivo* bioavailability tests in humans need to be performed for application to regulatory decision making. *In vivo* bioavailability studies in adult humans are planned as the next step in risk assessment for the CSSA soils.

4.3.5 Preliminary Remediation Goal Calculation

To determine PRGs using the US EPA Adult Lead Model, the parameter that can be changed based on the site-specific data is the Absorption Fraction (AF_S) parameter (absolute bioavailability). The AFs parameter is the fraction of lead in soil that is ingested daily and is absorbed by the gastrointestinal tract. The AFs parameter is a product of the absorption factor for soluble lead ($AF_{soluble}$) and the relative bioavailability of lead in soil compared to that of soluble lead ($RBF_{soil/soluble}$), as shown in the equation:

$$AF_S = AF_{soluble} * RBF_{soil/soluble}$$

In the absence of site-specific data the USEPA recommends a default value of 0.12, based on the assumption that the absorption factor for soluble lead ($AF_{soluble}$) is 0.2 and that the relative bioavailability of lead in soil compared to soluble lead ($RBF_{soil/soluble}$) is 0.6 (US EPA 2003):

$$AF_S = 0.2 * 0.6 = 0.12.$$

However, the USEPA states that site-specific bioavailability data are highly desirable because RBF soil/soluble is expected to vary significantly dependent upon lead speciation and particle sizes, both of which may vary from site-to-site (USEPA 2003).

Bioavailability of metallic lead has been shown to decrease with increasing particle size (Barltrop and Meek, 1979). There also is evidence to suggest that smaller soil particles (e.g.; <100-250-µm) are more likely to be incidentally ingested than larger particles because the particles adhere more readily to the skin (Kissel et al., 1996). A conservative value of 250-µm diameter is applied as an upper limit of bioavailability particle size for this study.

A number of other factors that affect the solubility and bioavailability of lead, as discussed by USEPA, include, but are not limited to, the following:

- The effect of food on lead bioavailability;

- The variability of lead intake;
- Differences in sensitivities to the adverse health effects from lead exposure in children and adults: and
- The effect of deficiencies in calcium, iron, zinc, copper, phosphorus, vitamin D, dietary lipids, and certain milk components (particularly lactose) on lead absorption.

Lead bioavailability also is expected to vary depending upon the chemical species of the lead in the soil. Ranging from most to least bioavailable, this is: lead carbonate > lead oxides > elemental lead > manganese/iron lead oxides and lead phosphates. This dependency is greatly affected by the chemistry of any amendments to the soil, in this case, phosphate in the form of Apatite II. Currently USEPA's lead exposure models do not accommodate input parameters for lead particle size or speciation. However, site-specific data from *in vitro* bioavailability studies, referred to as bioaccessibility, on the <250-µm particle size fraction of lead contaminated soils can be used in site-specific risk determinations and is recognized by EPA Region VIII.

Traditionally, toxicologists have used animal studies (termed *in vivo* tests, meaning that they occur within a living animal) to measure the amount of lead that would be bioavailable from a particular material. However, enough is currently known about how lead becomes bioavailable that *in vitro* studies, i.e., studies that occur in an artificial laboratory environment, can be used to estimate lead bioavailability (Ruby et al. 1999; Drexler 2003). This *in vitro* approach was used to estimate the reduction in oral lead bioavailability for soils from the Camp Stanley site, which had been amended with Apatite II during the PIMS treatment.

In a series of studies at the Columbia School of Public Health, lead-bearing soils were fed to adult human volunteers, and lead bioavailability was established based on stable lead isotope dilution in blood (Maddaloni et al. 1998). In one study, human volunteers were dosed with a soil from Joplin, Missouri, which had been amended with 1% soluble phosphorous fertilizer and allowed to weather in the environment for 18 months, the only human study of a site similar to the PIMS treatment site at CSSA. Results from these amended soils, when compared to their unamended counterparts, indicated a reduction in lead bioavailability of 69% (Graziano et al. 2001, 2003). However, when these same amended and unamended soils were evaluated using an *in vitro* test (identical to Ruby et al. 2003), the estimated reduction in lead bioavailability was only 38% (Graziano et al. 2001, 2003). These results suggested that the *in vitro* test under-predicted lead bioavailability reductions occurring in adult humans. The under-prediction of lead bioavailability based on the above results was approximately 55% (i.e., 38% divided by 69%).

Similar to the Graziano et al. (2001, 2003) study, the Camp Stanley soils have been amended with Apatite II phosphate material, i.e., fish bones. The most representative soils at Camp Stanley are the amended (Phase II) soils, the <250-µm fraction. An *in vitro* study by Ruby et al. (2003) determined that the Camp Stanley material produced an

estimated reduction in lead bioaccessibility of 26%. Adjusting this value to be more representative of adult humans would yield a reduction in absolute lead bioavailability of 47% (i.e., 26% divided by 55%) (Ruby et al. 2003). Therefore, for Camp Stanley soils amended with 5% by weight of Apatite II, a lead absolute bioavailability reduction of approximately 47% is considered an appropriate value for adult humans. Relating the phosphate-amended Joplin soils to the phosphate-amended CSSA soils compares systems that have similar total lead values, similar particle size fractions (< 250 µm), similar treatments (phosphate amendments), and identical *in vitro* bioaccessibility tests (Appendix D).

To determine the PRG for the Camp Stanley soils, the absolute bioavailability is reduced in the amended soils by 47%. Therefore, the $AF_{S,D}$ value is reduced by 47% according to the following equation:

$$AF_S = 0.12 * 0.53 = 0.0636.$$

As mentioned above, *in vivo* bioavailability studies in adult humans are planned as the next step in risk assessment for the CSSA soils and will provide more accurate input factors to the Adult Lead Model risk assessment.

4.3.6 Risk Assessment Results and Discussion

When the AF_S parameters were changed as described above, the PRGs were different for each of the model runs (default vs. Camp Stanley soils). The default model values and the Camp Stanley values are listed in Table 4.5.

Based on the analysis below, the PIMS amended soil reduces the risk to adults that may potentially ingest the < 250 µm soil size fraction at CSSA, and increases the cleanup goal at the SWMU B-20 site to over 2,300 mg/kg lead. Based on our statistical evaluation of background total lead values which give a UCL of the Mean, the total background UCL for lead is 1,720.5 mg/kg lead for this site. Therefore CSSA has achieved acceptable levels of lead at SWMU B-20 by implementing the PIMS treatment using Apatite II.

Table 4.5 Calculations of Preliminary Remediation Goals

Exposure Variable	Description of Exposure Variable	Units	Default Values	CSSA Values
$PbB_{fetal,\,0.95}$	95th percentile PbB in fetus	ug/dL	10	10
$R_{fetal/maternal}$	Fetal/maternal PbB ratio	--	0.9	0.9
BKSF	Biokinetic Slope Factor	ug/dL per ug/day	0.4	0.4
GSD_i	Geometric standard deviation PbB	--	2.1	2.1
PbB_0	Baseline PbB	ug/dL	1.5	1.5
IR_S	Soil ingestion rate (including soil-derived indoor dust)	g/day	0.050	0.050
AF_S	Absorption fraction (same for soil and dust)	--	0.12	0.0636
EF_S	Exposure frequency (same for soil and dust)	days/yr	219	219
AT_S	Averaging time (same for soil and dust)	days/yr	365	365
PRG	Preliminary Remediation Goal	ppm	1,235	2,331
* **PRG** = $\dfrac{([PbB_{95}fetal/(R*(GSD_i^{1.645})])-PbB_0)*AT_S}{BKSF*(IR_S*AF_S*EF_S)}$				

* U.S. EPA Technical Review Workgroup for Lead, Adult Lead Committee (US EPA 2003, using Equation 4 for homogeneous population)

4.3.4 Baseline or Competing Alternative

The baseline or competing alternative against which the performance was compared to is cement solidification with off-site disposal. Grouting (Cement Solidification) and off-site disposal is the presumptive technology at small arms firing ranges and is well-researched and well-used. Grouting encapsulates the contaminated soil and renders it immobile. The alkaline nature of grout also ensures that the treated material will likely pass a TCLP test. There is a significant increase in volume, depending upon the formulation, that ranges anywhere from 6% to 25%. Grouting is almost always used to treat for off-site disposal, and so is not an on-site treatment technology.

SECTION 5
COST ASSESSMENT

5.1 COST REPORTING

Cost issues are critical to the evaluation of ESTCP technologies. The PIMS field demonstration project developed and validated, to the extent possible, the expected operational costs of the demonstrated technology. Because this demonstration was an actual full field-scale remediation of a SWMU, these costs are actual and do not require scaling of any sort. This section includes a discussion of all relevant costs and related data that were tracked and documented during the demonstration so that operational costs of the technology can be estimated with a high degree of accuracy.

The overall costs presented in this section should be directly comparable for other sites applying this technology for *in situ* remediation. While it is recognized that there were some potential cost benefits due to previous efforts in UXO removal actions at SWMU B-20, the application of this technology would not be any more difficult or costly than what is represented in the Phase II field-scale demonstration cost assessment of this technology. It is anticipated that when applying this technology in other *in situ* applications, the equipment could vary (e.g.; use of a tractor with a disc and tiller instead of a scraper). Additionally, when firing range berms are treated for reuse as restored berms under pollution prevention guidelines, other activities, e.g., earth moving, sieving, rebuilding, etc., may need to be performed and may add costs. Deep soils may require the use of augering or other methods to emplace the Apatite II.

The Apatite II material costs, including the delivery charges, provide the best basis for projecting costs of implementing this technology. The process chemicals, (i.e.; Apatite II material) and the shipping charges, represent approximately 50% of the expended costs for the Phase II field-scale demonstration efforts. This results from the ease of application of the Apatite II material. Process equipment consisted of a front-end loader and a scraper (motor grader) which were used to move and mix materials. Labor consisted of a construction supervisor, two heavy equipment operators and an independent observer/health and safety site monitor. Table 5.1 presents the Phase II field-scale demonstration costs incurred for the treatment of approximately 2,500 yd^3 of lead-contaminated soil. Fixed costs include start-up costs (e.g.; planning, site characterization, mobilization, and site preparation costs) and operating costs such as process chemical (Apatite II material) and raw material purchases (i.e., soil cover and vegetation). Operational costs include equipment rental, labor, and personal protective equipment (PPE). These costs account for nearly all of the costs of implementing this technology. Re-occurring costs such as performance testing are included; however, these costs represent a small fraction of the cost and may not be required for long-term monitoring when regulatory acceptance is obtained. Therefore, monitoring costs have been included for quarterly sampling by CSSA for a period of five years at which time a

re-evaluation of the remedial efficacy of the technology should be completed and appropriate recommendations made to the regulators.

Table 5.1 Cost Tracking

Item	Basis	Field-Scale Costs
Start-up Costs Planning	Planning costs include preparation of Work Plan, Sampling and Analysis Plan, and Health and Safety Plan.	$5,000
Site Characterization	Sampling and analysis	$1,500
Mobilization	Mobilization of equipment only	$550
Site Preparation	Includes clearing and grubbing of vegetation and large debris	$500
Demobilization	Equipment demobilization only	$550
Total Start-up Costs		$8,100
OPERATING COSTS *Direct Environmental Activity Costs*		
Capital Equipment Rental	Equipment rental included front-end loader and motor grader.	$2,375
Ancillary Equipment Rental	None	$0
Supervision	Included one supervisor for 40 hours @ $60/hr	$2,400
Operator Labor	Included two operators for 40 hours at $35/hr	$1,400
Observer/Health and Safety monitor	Included one observer for 40 hours @ $65/hr	$2,600
Maintenance	None	$0
Utilities	None	$0
Raw Materials	Includes 6-inch soil and vegetative cover.	$4,500
Process Chemicals	Included 100 tons of Apatite II material	$22,500
Consumables, Supplies	Include PPE	$100
Sampling and Analysis	Includes performance testing	$300
Long-term Monitoring	Includes quarterly sampling for five years @ 5% inflation (estimated at $2,500, however is not included as part of treatment cost)	$0
Shipping	Included shipment from Apatite II generating plant to CSSA	$30,000
Indirect Environmental Activity Costs		$0
Environmental and Safety Training	None	$0
OSHA Ambient Environment Sampling	None	$0
Waste manifesting (if any)	None	$0
Total Operational Costs		$66,175
Total Project Costs		$8,100
Total Cost/Yd^3 of soil treated		**$24.76**
Variable Cost/Yd^3 of soil		$15

5.2 COST ANALYSIS

Cost Comparison

Grouting (cement solidification) and off-site disposal is the alternative baseline technology at small arms firing ranges (SARs) and is considered the alternative baseline technology to PIMS. Most solidification/stabilization technologies are not used in site closure actions where contaminant removal is specified, but are for used for treatment prior to offsite disposal. The PIMS demonstration provides an adequate comparison to other soil solidification/stabilization technologies because of TCLP testing of the treated soil. Therefore, to compare costs for other technologies such as solidification, the costs are compared as if they were able to treat to waste disposal criteria. For example, in comparing the PIMS technology to cement stabilization, it is necessary to assume that the treatment can occur to specific criteria, State of Texas Class 2 Non-hazardous waste criteria, as specified in 30 TAC 335 subchapter R.

This PIMS demonstration can also be compared to in situ remediation technologies. In situ remediation technologies are used in site closure actions where contaminant removal is specified (i.e., State of Texas Risk Reduction Standard 1 [RRS1] or in current standard State of Texas Risk Reduction Program Standard A Tier 1 closures). These closure standards specify contamination removal to certain levels (i.e., RRS1 – to background levels, TRRP Standard A Tier 1 – to 1,600 mg/kg). The goal of this PIMS demonstration is to provide data to allow TRRP Standard A Tier 1 closure. Comparable technologies in this category include other stabilization technologies and extraction technologies discussed in Section 1. Some of these technologies have been attempted at CSSA by Parsons in pilot-scale treatability studies, including solidification using Portland Cement, and have directly comparable costs and performances.

Figure 5.1 presents a comparison of the technologies that have been tested at CSSA compared to the PIMS Apatite II technology. The comparison is made on derived costs per cubic yard or reported costs per cubic yard of contaminated soil. Below is a short description of each technology demonstrated for metal remediation at CSSA.

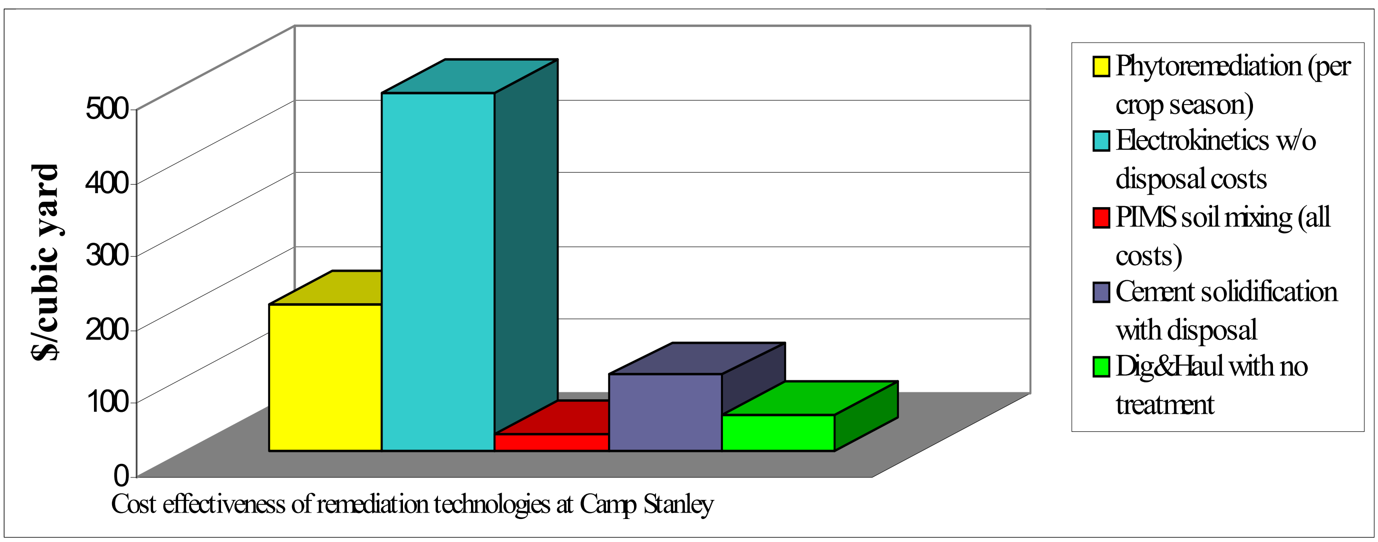
No Treatment and Off-Site Disposal - Simply excavating the contaminated soil and disposing of it off-site is the presumptive remedy case and involves simple earth moving equipment. Excavation with no treatment is $\$40/yd^3$ at Camp Stanley (Figure 5.1). Added to this is the waste disposal cost of $\$68/yd^3$, making the total cost of disposal with no treatment $\$118/yd^3$. This is the reference cost that must be addressed in order for any technology to compete at this and similar sites.

Grouting and Off-Site Disposal - Grouting (Cement Solidification) and Off-Site Disposal is the alternative baseline technology at small arms firing ranges and is well-researched and well-used. At CSSA, grouting and off-site disposal was the next most cost-effective to PIMS ($\$104/yd^3$).

Phytoremediation – Parsons demonstrated phytoremediation at CSSA, and found that all of the issues associated with this technology occurred, e.g., slow action over many growing seasons, poor growth of necessary species, inefficient movement of contaminant from soil to the roots, contaminated biomass concentrated at the surface for dispersion or ingestion by animals, and a long-term commitment over about 20 years. Phytoremediation was not very cost beneficial at CSSA (\$175/yd^3 per crop season) and may not achieve clean-up goals.

Electrokinetic Remediation – Electrokinetics also failed at CSSA because of the usual reasons of poor mobilization and permeabilities, non-favorable soil pHs, and scale-up problems. For the CSSA site, electrokinetic remediation was not cost-effective (\$475/yd^3) and failed to meet anticipated objectives.

Figure 5.1
Technology Cost Comparison



Cost Basis

The basis of the costs presented in Table 5.1 is derived from the actual field cost for implementing the Phase II field-scale demonstration. The Phase II effort consisted of mixing 3,000 yd^3 of lead-contaminated soil with approximately 75 tons of Apatite II and providing a 6-inch clean vegetated soil cover. The treated soils were placed in an area measuring 100 ft by 200 ft with a depth of approximately 3.5 ft. The mixing and emplacement effort was accomplished in approximately one workweek using one equipment operator and a supervisor who operated the second piece of equipment. The site observer was available to ensure efforts were completed according to finalized plans, quality assurance testing, and to document field efforts.

Cost Drivers

The largest cost drivers for the PIMS remedial technology include the cost of the Apatite II material and the shipment of the material to the work site. As a commodity, price and supply of the PIMS Apatite II material are subject to market forces and will change over time as with any other commodity. Currently the cost of the PIMS material has stabilized at approximately $350/ton. The original purchase price of PIMS material in the year 2000 was approximately $225/ton.

Life Cycle Costs

An estimated life-cycle cost for the PIMS remedial technology includes the following considerations:

- Fixed costs (e.g., permitting and regulatory requirements, site characterization, benchscale treatability testing, site preparation, engineering and administrative support, equipment mobilization, demobilization, etc.);

- Variable costs (e.g., site excavation, equipment lease, labor, sampling and analysis, Apatite II material, shipping, etc.); and

- Future liability implications and costs associated with monitoring for a period of five years.

The fixed costs represent a one-time cost incurred that would be similar to any size project. That is, the efforts that represent fixed cost include planning, site characterization, and mobilization/demobilization costs. For the Phase II field-scale demonstration efforts these costs represent only a small fraction of the total costs (i.e., approximately a fifth of the total costs). It is expected that these costs would be stable for future efforts and the costs would be considerably less of the total amount as the amount of treated soil increases.

Variable costs represent costs that are directly dependent on the expected amount of contaminated media to be treated. The largest cost item is that of the Apatite II material and the associated shipping costs. These costs represent over fifty percent of the total cost for the remedial technology. Shipping costs are especially variable, with shipping costs to CSSA estimated at nearly the same cost as the current costs for Apatite II material (i.e.; approximately $300/ton). However, shipment to Seoul, South Korea has an approximate cost of $180/ton. This is because of the location of the facility producing the Apatite II material and methods of shipment. In shipping to South Korea, the material is loaded on a ship and transported directly to Seoul, South Korea. In shipping to San Antonio, the material was shipped via boat and train and then completed its journey to CSSA by truck. It is anticipated that as new markets are opened to provide the Apatite II material, the shipping cost will decrease due to the potential proximity of the new generation site.

Future liability implications and costs associated with this technology are uncertain at this time. As stated earlier, this technology does not remove the contaminant but changes it into a much more stable molecular form. Therefore, for the Phase II field-scale demonstration efforts lead is still available in the soil matrix and would continue to be regulated by the USEPA and TCEQ. However, performance data has shown that the bioavailability of the lead is reduced and that the lead is not leaching from the soils, thus gaining favorable closure standards where monitoring or deed recordation is not required. For estimating costs for addressing future liability, a period of five years of quarterly monitoring was specified per the National Contingency Plan (NCP). Upon completion of the five years of monitoring, an evaluation of the data is recommended to determine if further monitoring is necessary.

SECTION 6
IMPLEMENTATION ISSUES

6.1 ENVIRONMENTAL CHECKLIST

The use of the PIMS remedial technology normally does not require any permitting efforts or special notifications if accomplished *in situ*. The *in situ* application alleviates any of the RCRA requirements normally associated with *ex situ* treatment of hazardous media. If the mixing efforts were to be accomplished ex-situ then formal waste characterization efforts would be required. If the results of the waste characterization indicate that the contaminated soil or other media is hazardous then associated waste analysis plans and/or RCRA permit modification would be necessary to allow the remedial technology to be used. The treatment system and technology would have to be permitted as a RCRA treatment unit and placed on the facility's Notice or Registration or, if treating within a container, a permit modification to the facility's waste analysis plan would be required. Permit modifications require at least a 90-day notification period plus a public comment period if the facility's permit is modified to include a treatment unit.

For the Phase II field-scale demonstration efforts the contaminated soil media was analyzed to determine the waste classification. Results of analyses indicated that the soils for the PIMS field demonstration efforts met Class 1 Non-hazardous criteria. Therefore, treatment of the sieved soils at SWMU B-20 could occur without the cumbersome permitting or planning requirements of RCRA.

Additionally, with the *in situ* application of the Apatite II material, a determination as to the amount of rubble or oversize cobbles or stones is required. An overly large amount of oversized rubble or rocks could cause the mixing efforts to be difficult or incomplete. As with any *in situ* application, frozen soil or tundra would also hinder mixing operations.

6.2 OTHER REGULATORY ISSUES

For lead-affected soil, the TRRP Tier 1 PCL is 500 mg/kg (residential) and 1,600 mg/kg (commercial/industrial). Historically, Synthetic Precipitation Leaching Procedure (SPLP) or TCLP tests have been used in determining site-specific groundwater protection soil protective concentration limits for lead in affected soils. However, the aggressive acidic treatment to which the soils are subjected in the TCLP/SPLP extraction procedure do not always provide appropriate results to derive lead soil-water partition coefficients (K_d) and may over predict the amount of leachable lead that is impacting groundwater/surface water for many sites. The demonstration efforts used actual field leachate data for determining the potential impacts to surface water run-off.

To calculate a critical PCL for the demonstration site bioaccessibility data were used to estimate a preliminary remediation goal using the USEPA Adult Lead Model as discussed in Section 4. Results indicate that the PIMS amended soil reduces the risk to adults that may potentially ingest the < 250-µm soil size fraction at CSSA, and increases the cleanup goal at the SWMU B-20 site to over 2,300 mg/kg lead. Based on our statistical evaluation of background total lead values which give a UCL of the Mean, the total background UCL for lead is 1,720.5 mg/kg lead for this site. Therefore, CSSA has achieved acceptable levels of lead at SWMU B-20 by the PIMS treatment using Apatite II.

6.3 END-USER ISSUES

It is anticipated that the end users of this technology will include all DoD sites with small arms firing ranges which are closed or abandoned and need an effective and viable option in addressing potential lead contamination resulting from use. Numerous military installations have inactive or abandoned firing range sites that present a potential regulatory concern because of elevated concentrations of metals (especially lead) in site soils. Traditionally, these sites have undergone a costly and time-consuming multiphase investigation process, including remedial investigation, baseline risk assessment, feasibility study, and remedial design. The purpose of this demonstration is to establish a remedial technology that is potentially more cost-effective and efficient than conventional remediation processes (e.g., cement based stabilization).

The concern of the end-user for this technology for remediation of range soils is the applicability to close the site without contaminant removal. This technology has been proven to be competitive with other forms of waste treatment, such as off-site disposal because of the simplicity of this technology. However, the real success would be to gain regulatory approval of this technology for closing to standards that would be protective of human health and the environment with no deed recordation and/or monitoring requirements. Additionally, because the source of the Apatite II material is limited, ~10,000 tons/year generated, there is a concern that there will not be enough of the material to use at all of the potential application sites. It is recognized that new sources of the Apatite II material should be identified and cultivated. There are several potential sources identified and new techniques have been discussed in potentially providing additional sources of the Apatite II material. Efforts are underway by the present manufacturer to expand to other commercial fishing locations (a Gulf of California plant is being opened in 2004) and by the UK licensee to develop correct manufacturing methods in Norway and Russia. Slater (UK) Limited has also begun small bench-scale studies on commercial composting of fish farm waste.

Future efforts to transfer this technology to the end-user include the attendance at conferences where environmental professional meet to discuss results of innovative technologies. Additionally, working with firms like Parsons or CH_2M Hill expands the potential for identification of sites where application of the PIMS remedial technology would be appropriate. To date, there are several sites that have been identified for use of

this technology by Parsons, AMEC and smaller firms like Brice, Inc, or MSE, Inc. As the technology matures and becomes accepted, it is anticipated that there may be a short fall in the production of Apatite II material.

SECTION 7
REFERENCES

Anderson and Coats, 1994. *Innovative Site Remediation Technology Stabilization/Solidification.* Water Environment Federation, Alexandria, Virginia.

Chen, X.-B., J. V. Wright, J. L. Conca, and L. M. Peurrung 1997a "Evaluation of Heavy Metal Remediation Using Mineral Apatite", Water, Air and Soil Pollution, vol. 98, p. 57-78.

Chen, Xiaobing, Judith Wright, James L. Conca, and Loni M. Peurrung. 1997b. "Effects of pH on Heavy Metal Sorption on Mineral Apatite", Env. Science and Technology, 31:624-631.

Conca, J. L., N. Lu, G. Parker, B. Moore, A. Adams, J. V. Wright and P. Heller. 2000. "PIMS – Remediation of Metal Contaminated Waters and Soils", in *Remediation of Chlorinated and Recalcitrant Compounds,* Eds., Wickramanayake, Gavaskar, Gibbs and Means, Battelle Memorial Institute, Columbus, Ohio, vol. 7, p. 319-326.

Conca, James and Judith Wright. 1999. "PIMS: A Simple Technology for Clean-Up of Heavy Metals and Radionuclides Throughout the World," In Environmental Challenges of Nuclear Disarmament, The Proceedings of the NATO Advanced Research Workshop, Krakow, ed. T.E. Baca, Poland, November 8-13,1998, p. 1-13.

Conca, J. L. (1997) Phosphate-Induced Metal Stabilization (PIMS). Final Report to the U.S. Environmental Protection Agency #68D60023.

Conca, J. L. (1998) Success Mine Apatite Remediation Project. Report to the Idaho State Department of Environmental Quality #QC038900.

Drexler, J. 2003. Bioassays: Past and future. Presentation at the U.S. EPA Bioavailability Workshop. April 15, 2003, in Tampa, Florida.

Graziano, J.H., N.J. Lolocono, M. Maddaloni, and C.C. Blum. 2001. Assessing the oral bioavailability of lead in soil to humans. Presentation at the 40th Annual Meeting of the Society of Toxicology, March 28, 2001.

Graziano, Joseph H. and Jim Shine, 2003, "NIEHS/EPA Metals-Bioavailability." US EPA Technology Innovation Office Interactive Internet Seminar Series on Metals, http://www.clu-in.org/conf/tio/metals_040903/

Kissel, J., K. Richter, R Duff, and R Fenske. 1996. Factors affecting soil adherence to skin in hand press trials. *Bulletin of Environmental Contamination and Toxicology* 56:722-728.

Lower, S. K., P. A. Maurice, S. J. Traina, and E. H. Carlson. 1998. Aqueous Pb sorption by hydroxylapatite: Applications of atomic force microscopy to dissolution, nucleation and growth studies. Amer. Min. 83: 147-158.

Ma, Q. Y., S. J. Traina, and T. J. Logan. 1993. In Situ Lead Immobilization by Apatite. Env. Sci. Tech. 27: 1803-1810.

Maddaloni, M., N. Lolacono, W. Manton, C. Blum, J. Drexler, and J. Graziano. 1998. Bioavailability of soilborne lead in adults by stable isotope dilution. Environmental Health Perspectives 106(6): 1589-1594.

Parsons ES 1994a. Partial Facility Closure Plan, B-20 Detonation Area, Camp Stanley Storage Area, Engineering Science, Inc., Austin, Texas, March 1994.

Parsons ES 1995a. Remediation Investigation Report for B-20 Former Open Burn/Open Detonation Area, Camp Stanley Storage Area, Parsons Engineering Science, Inc., Austin, Texas, June 1995.

Rice, J.A. 1995. *Mathematical Statistics and Data Analysis.* Duxbury Press. Belmont, California.

Ruby, M.V., A. Davis, T.E. Link, R. Schoof, R.L. Chaney, G.B. Freeman, and P. Bergstrom. 1993. Development of an in vitro screening test to evaluate the in vivo bioaccessibility of ingested mine-waste lead. Environ. Sci. Technol. 27(13):2870–2877.

Ruby, M.V., A. Davis, R. Schoof, S. Eberle, and C.M. Sellstone. 1996. Estimation of lead and arsenic bioavailability using a physiologically based extraction test. Environ. Sci. Technol. 30(2):422–430.

Ruby, M.V., R. Schoof , W. Brattin, M. Goldade, et al. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environ. Sci. Technol. 33(21):3697–3705.

USEPA, 1994. *Guidance on Residential Lead-Based Paint, lead Contamination Dust, and Lead Contaminated Soil.* Memorandum from Lynn Goldman, Assistant Administrator, Office of Prevention, Pesticides, and Toxic Substances. July, 1994.

USEPA, 1997. *Engineering Bulletin: Technology Alternatives for the Remediating of Soils Contaminated with As, Cd, Cr, Hq, and Pb.* Office of Emergency and Remedial Response. EPA/540/S-97/500. August

USEPA, 2003. *Recommendations of the Technical Review Workgroup for Lead for an Approach to Assessing Risks Associated with Adult Exposure to Lead in Soil.* Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, EPA-540-R-03-001, OSWER #9285.7-54, January 2003. Washington, DC.

Wright, Judith, Hans Schrader, and W. T. Holser. 1987a. "Paleoredox Variations in Ancient Oceans Recorded by REE in Fossil Apatite." *Geoch. Cosmoch. Acta*, 51:631-644.

Wright, Judith, James F. Miller, and W. T. Holser. 1987b. “Chemostratigraphy of Conodonts Across the Cambrian-Ordovician Boundary: Western U.S. and SE China.” In *Conodonts: Investigative Tech. and Appl.*, Ed., R. L. Austin. Ellis Horwood, Ltd., London, pp. 259-286.

Wright, Judith (1990) “Conodont Apatite: Structure and Geochemistry,” In Biomineralization: Patterns, Processes and Evolutionary Trends, ed. Joseph Carter. Van Nostrand Reinhold, New York, p. 445-459.

Wright, Judith, Loni M. Peurrung, Timothy E. Moody, James L. Conca, Xiaobing Chen, Paul P. Didzerekis and Eric Wyse . 1995. In Situ Immobilization of Heavy metals in Apatite Mineral Formulations, *Technical Report to the Strategic Environmental Research and Development Program, Department of Defense*, Pacific Northwest Laboratory, Richland, WA, 154 p.

Wright, J. V. and J. L. Conca. 1998. United States Patent #6217775 STABILIZATION AND REMEDIATION OF SOIL, WATER AND WASTES CONTAMINATED WITH METALS USING FISH BONES AND HARD PARTS, (issued 2000) U.S. Patent Office, WA, D.C.

Wright, Judith, Bryony Hanson, and James L. Conca, 2003. “PIMS: an Apatite II permeable reactive barrier to remediate groundwater containing Zn, Pb and Cd.” *Environ. Geosci.* (in press).

SECTION 8
POINTS OF CONTACT

Table 8.1
Points of Contact

POINT OF CONTACT Name	ORGANIZATION Name/Address	PHONE/FAX/ E-MAIL	ROLE IN PROJECT
Dr. Judith Wright	UFA Ventures, Inc. 403 West Riverside Dr. Carlsbad, NM 88220	(505) 628-0916 FAX-0915 judith@ufaventures.com judith@pimsnw.com	Principal Investigator and Project Lead
Dr. James Conca	Los Alamos National Laboratory (LANL) MS A141 1400 University Drive Carlsbad, NM 88220	Office: (505) 234-5555 Cell: (505) 706-0214 FAX (505) 887-3051 jconca@lanl.com	Project Lead
Brian Murphy	CSSA 25800 Ralph Fair Road Boerne, TX 78015-4800	(210) 698-5208 FAX 295-7386 murphyb@campstanley.net	Post Environmental Officer
Teresa DuPriest	AFCEE/ERD 3300 Sidney Brooks-City Base, TX 78235-5112	(210) 536-4745 FAX-9026 Teri.Dupriest@hqafcee.brooks.af.mil	QA Evaluator
Ken Rice	Parsons Inc. 8000 Centre Park, Suite 200 Austin, TX 78754	(512) 719-6050 FAX-6099 Ken.R.Rice@parsons.com	Project Manager For CSSA
Greg Lyssy	USEPA Region VI 1445 Ross Avenue (6PD-N) Dallas, TX 75202	(214) 665-8317 FAX (214 665-6660 lyssy.gregory@epa.gov	Federal Regulator
Sonny Rayos	Corrective Action Section Texas Commission on Environmental Quality MC-127, PO Box 13087 Austin, TX 78741-3087	(512) 239-2371 FAX (512) 239-2346 srayos@tceq.state.tx.us	State Regulator

Dated Signature of Project Lead

Judith Wright, Ph.D.

August 15, 2003

Appendix A
Analytical Results Supporting Experimental Design

The analytical results used in supporting the experimental design of the PIMS field demonstration and included as data tables.

Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000
Solid Waste Management Unit B-20

	Soil Comparison Criteria													
Sample ID								B20-SIFT06				B20-SIFT06			
Sample Date								03/28/00				03/28/00			
Sample Type								N1				FD1			
Soil Type								Soil				Soil			
Beginning Depth								5				5			
Ending Depth								6				6			
Lab ID								AP90409				AP90410			
	Lab MDL APPL	Lab MDL OGB	Lab MDL APPL	Lab MDL OGB	Background[a] Soil	TRRP-Tier 1 (Res. $^{Tot}Soil_{Comb}$)	TRRP-Tier 1 (Ind. $^{Tot}Soil_{Comb}$)	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)															
Barium	0.08	0.04	1.0	1.0	186	2,800	39,000	**187.85**	**M**	**1**	**1.0**	**193.**	**M**	**1**	**1.0**
Chromium	0.10	0.08	20.0	20.0	40.2	30,000	95,000	20.6	J	1	20.0	19.9	F	1	20.0
Copper	0.19	0.07	2.0	2.0	23.2	550	38,000	**68.33**	**M**	**1**	**2.0**	**97.95**	**M**	**1**	**2.0**
Nickel	0.12	0.12	2.0	2.0	35.5	840	8,800	11.27	J	1	2.0	13.83	J	1	2.0
Zinc	0.63	0.42	2.0	2.0	43.2	9,900	250,000	**89.3**	**M**	**1**	**2.0**	**104.82**	**M**	**1**	**2.0**
SW7060A (mg/kg)															
Arsenic	0.04	0.032	0.5	0.5	19.6	24	200	5.2	M	1	0.5	5.0	M	1	0.5
SW7131A (mg/kg)															
Cadmium	0.01	0.022	0.1	0.1	3	52	8,500	0.59		5	0.5	1.15		5	0.5
SW7421 (mg/kg)															
Lead	0.13	0.00032	0.5	0.005	84.5	500	1,600	**204.4**	**M**	**50**	**0.25**	**207.15**	**M**	**50**	**0.25**
SW7471A (mg/kg)															
Mercury	0.01	0.024	0.1	0.1	0.77	8.3	19	0.09	F	1	0.1	0.13	J	1	0.1
SW8260B (mg/kg)															
Methylene chloride	0.0007		0.005		--	390	960								
Toluene	0.0003		0.005		--	4,500	8,200								
Trichloroethene	0.001		0.01		--	150	310								

Sample ID	B20-SIFT06				B20-SIFT06				B20-SIFT07			
Sample Date	04/21/00				04/21/00				03/28/00			
Sample Type	N1				FD1				N1			
Soil Type	Soil				Soil				Soil			
Beginning Depth	5				5				9			
Ending Depth	6				6				10			
Lab ID	AP91508				AP91509				AP90413			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)												
Barium									**232.13**	**J**	**1**	**1.0**
Chromium									22.4	J	1	20.0
Copper									**84.63**	**J**	**1**	**2.0**
Nickel									13.87	J	1	2.0
Zinc									**101.6**	**J**	**1**	**2.0**
SW7060A (mg/kg)												
Arsenic									9.7	J	5	2.5
SW7131A (mg/kg)												
Cadmium									0.59		5	0.5
SW7421 (mg/kg)												
Lead									**322.52**	**J**	**100**	**0.5**
SW7471A (mg/kg)												
Mercury									0.09	F	1	0.1
SW8260B (mg/kg)												
Methylene chloride	0.0007	U	1	0.005	0.0007	U	1	0.005				
Toluene	0.0003	U	1	0.005	0.0003	U	1	0.005				
Trichloroethene	0.002	F	1	0.01	0.002	F	1	0.01				

Tables present all laboratory results for analytes detected above the method detection limit.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:32313, 32499
O'Brien and Gere: 5439

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.
-- No risk reduction standard or background level available
Bte Brackett-Tarrant
Cb Crawford and Bexar
DL Dilution
FD1 Field Duplicate
GWP-Ind Soil MSC based on groundwater protection
Kr Krum Complex
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SAI-Ind Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000
Solid Waste Management Unit B-20

Sample ID								B20-SIFT08				B20-SIFT09				B20-SIFT10				B20-SIFT11				B20-SIFT11			
Sample Date								03/28/00				03/28/00				03/28/00				03/28/00				04/21/00			
Sample Type								N1				N1				N1				N1				N1			
Soil Type								Soil				Soil				Soil				Soil				Soil			
Beginning Depth								0.5				1				6				7				7			
Ending Depth								1				2				7				8				8			
Lab ID								AP90414				AP90415				AP90416				AP90417				AP91512			
	Soil Comparison Criteria																										
	Lab MDL APPL	**Lab MDL OGB**	**Lab MDL APPL**	**Lab MDL OGB**	**Background[a]** Soil	**TRRP-Tier 1 (Res. $^{Tot}Soil_{Comb}$)**	**TRRP-Tier 1 (Ind. $^{Tot}Soil_{Comb}$)**	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)																											
Barium	0.08	0.04	1.0	1.0	186	2,800	39,000	**264.73**	**J**	**2**	**2.0**	**190.16**	**J**	**1**	**1.0**	**200.46**	**J**	**1**	**1.0**	169.94	J	1	1.0				
Chromium	0.10	0.08	20.0	20.0	40.2	30,000	95,000	22.7	J	1	20.0	16.1	F	1	20.0	20.6	J	1	20.0	19.1	F	1	20.0				
Copper	0.19	0.07	2.0	2.0	23.2	550	38,000	**85.18**	**J**	**1**	**2.0**	**845.27**	**J**	**5**	**10.0**	**125.73**	**J**	**1**	**2.0**	**124.32**	**J**	**1**	**2.0**				
Nickel	0.12	0.12	2.0	2.0	35.5	840	8,800	13.41	J	1	2.0	9.77	J	1	2.0	11.83	J	1	2.0	12.02	J	1	2.0				
Zinc	0.63	0.42	2.0	2.0	43.2	9,900	250,000	**110.48**	**J**	**1**	**2.0**	**139.57**	**J**	**1**	**2.0**	**121.72**	**J**	**1**	**2.0**	**129.89**	**J**	**1**	**2.0**				
SW7060A (mg/kg)																											
Arsenic	0.04	0.032	0.5	0.5	19.6	24	200	5.1	J	1	0.5	9.7	J	5	2.5	9.9	J	5	2.5	8.6	J	5	2.5				
SW7131A (mg/kg)																											
Cadmium	0.01	0.022	0.1	0.1	3	52	8,500	0.86		5	0.5	0.77		5	0.5	0.85		5	0.5	0.72		5	0.5				
SW7421 (mg/kg)																											
Lead	0.13	0.00032	0.5	0.005	84.5	500	1,600	**446.78**	**J**	**100**	**0.5**	**5,006.01**	**J**	**1250**	**6.25**	**2,704.96**	**J**	**1000**	**5.0**	**869.32**	**J**	**250**	**1.25**				
SW7471A (mg/kg)																											
Mercury	0.01	0.024	0.1	0.1	0.77	8.3	19	0.08	F	1	0.1	0.2	J	1	0.1	0.16	J	1	0.1	0.09	F	1	0.1				
SW8260B (mg/kg)																											
Methylene chloride	0.0007		0.005		--	390	960																	0.0018	F	1	0.005
Toluene	0.0003		0.005		--	4,500	8,200																	0.0003	U	1	0.005
Trichloroethene	0.001		0.01		--	150	310																	0.002	F	1	0.01

Tables present all laboratory results for analytes detected above the method detection limit.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:32313, 32499
O'Brien and Gere: 5439

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.

--	No risk reduction standard or background level available
Bte	Brackett-Tarrant
Cb	Crawford and Bexar
DL	Dilution
FD1	Field Duplicate
GWP-Ind	Soil MSC based on groundwater protection
Kr	Krum Complex
MDL	Method Detection Limit
N1	Environmental Sample
NA	Not Available
RL	Reporting Limit
SAI-Ind	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL	Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000
Solid Waste Management Unit B-20

	Soil Comparison Criteria						
	Lab MDL APPL	Lab MDL OGB	Lab MDL APPL	Lab MDL OGB	Background[a] Soil	TRRP-Tier 1 (Res. $^{Tot}Soil_{Comb}$)	TRRP-Tier 1 (Ind. $^{Tot}Soil_{Comb}$)
SW6010B (mg/kg)							
Barium	0.08	0.04	1.0	1.0	186	2,800	39,000
Chromium	0.10	0.08	20.0	20.0	40.2	30,000	95,000
Copper	0.19	0.07	2.0	2.0	23.2	550	38,000
Nickel	0.12	0.12	2.0	2.0	35.5	840	8,800
Zinc	0.63	0.42	2.0	2.0	43.2	9,900	250,000
SW7060A (mg/kg)							
Arsenic	0.04	0.032	0.5	0.5	19.6	24	200
SW7131A (mg/kg)							
Cadmium	0.01	0.022	0.1	0.1	3	52	8,500
SW7421 (mg/kg)							
Lead	0.13	0.00032	0.5	0.005	84.5	500	1,600
SW7471A (mg/kg)							
Mercury	0.01	0.024	0.1	0.1	0.77	8.3	19
SW8260B (mg/kg)							
Methylene chloride	0.0007		0.005		--	390	960
Toluene	0.0003		0.005		--	4,500	8,200
Trichloroethene	0.001		0.01		--	150	310

Sample ID	B20-SIFT12				B20-SIFT13				B20-SIFT14			
Sample Date	03/28/00				03/28/00				03/28/00			
Sample Type	N1				N1				N1			
Soil Type	Soil				Soil				Soil			
Beginning Depth	2				0.5				1			
Ending Depth	3				1.				1			
Lab ID	AP90418				AP90419				AP90420			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)												
Barium	127.12	J	1	1.0	**253.31**	**M**	**2**	**2.0**	**203.42**	**J**	**1**	**1.0**
Chromium	14.7	F	1	20.0	18.7	F	1	20.0	20.4	J	1	20.0
Copper	**82.15**	**J**	**1**	**2.0**	**73.69**	**M**	**1**	**2.0**	**800.58**	**J**	**5**	**10.0**
Nickel	9.42	J	1	2.0	10.91	J	1	2.0	11.7	J	1	2.0
Zinc	**87.9**	**J**	**1**	**2.0**	**88.13**	**M**	**1**	**2.0**	**167.68**	**J**	**1**	**2.0**
SW7060A (mg/kg)												
Arsenic	9.0	J	5	2.5	10.9	M	5	2.5	3.3	J	1	0.5
SW7131A (mg/kg)												
Cadmium	0.71		5	0.5	0.71		5	0.5	0.66		5	0.5
SW7421 (mg/kg)												
Lead	**386.56**	**J**	**100**	**0.5**	**242.38**	**M**	**50**	**0.25**	**40,509.44**	**J**	**10000**	**50.0**
SW7471A (mg/kg)												
Mercury	0.15	J	1	0.1	0.06	F	1	0.1	0.34	J	1	0.1
SW8260B (mg/kg)												
Methylene chloride												
Toluene												
Trichloroethene												

Sample ID	B20-SIFT14				B20-SIFT15			
Sample Date	03/28/00				03/28/00			
Sample Type	FD1				N1			
Soil Type	Soil				Soil			
Beginning Depth	1				4			
Ending Depth	1				5			
Lab ID	AP90421				AP90422			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)								
Barium	**256.13**	**J**	**2**	**2.0**	177.42	J	1	1.0
Chromium	20.2	J	1	20.0	22.9	J	1	20.0
Copper	**145.16**	**J**	**1**	**2.0**	**55.29**	**J**	**1**	**2.0**
Nickel	12.31	J	1	2.0	13.27	J	1	2.0
Zinc	**155.64**	**J**	**1**	**2.0**	**75.03**	**J**	**1**	**2.0**
SW7060A (mg/kg)								
Arsenic	14.6	J	5	2.5	15.1	J	5	2.5
SW7131A (mg/kg)								
Cadmium	0.71		5	0.5	**131.81**		**500**	**50.0**
SW7421 (mg/kg)								
Lead	**504.18**	**J**	**250**	**1.25**	**249.12**	**J**	**50**	**0.25**
SW7471A (mg/kg)								
Mercury	0.25	J	1	0.1	0.03	F	1	0.1
SW8260B (mg/kg)								
Methylene chloride								
Toluene								
Trichloroethene								

Tables present all laboratory results for analytes detected above the method detection limit.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:32313, 32499
O'Brien and Gere: 5439

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.

--	No risk reduction standard or background level available
Bte	Brackett-Tarrant
Cb	Crawford and Bexar
DL	Dilution
FD1	Field Duplicate
GWP-Ind	Soil MSC based on groundwater protection
Kr	Krum Complex
MDL	Method Detection Limit
N1	Environmental Sample
NA	Not Available
RL	Reporting Limit
SAI-Ind	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL	Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000
Solid Waste Management Unit B-20

Soil Comparison Criteria

	Lab MDL APPL	Lab MDL OGB	Lab MDL APPL	Lab MDL OGB	Background[a] Soil	TRRP-Tier 1 (Res. $^{Tot}Soil_{Comb}$)	TRRP-Tier 1 (Ind. $^{Tot}Soil_{Comb}$)
SW6010B (mg/kg)							
Barium	0.08	0.04	1.0	1.0	186	2,800	39,000
Chromium	0.10	0.08	20.0	20.0	40.2	30,000	95,000
Copper	0.19	0.07	2.0	2.0	23.2	550	38,000
Nickel	0.12	0.12	2.0	2.0	35.5	840	8,800
Zinc	0.63	0.42	2.0	2.0	43.2	9,900	250,000
SW7060A (mg/kg)							
Arsenic	0.04	0.032	0.5	0.5	19.6	24	200
SW7131A (mg/kg)							
Cadmium	0.01	0.022	0.1	0.1	3	52	8,500
SW7421 (mg/kg)							
Lead	0.13	0.00032	0.5	0.005	84.5	500	1,600
SW7471A (mg/kg)							
Mercury	0.01	0.024	0.1	0.1	0.77	8.3	19
SW8260B (mg/kg)							
Methylene chloride	0.0007		0.005		--	390	960
Toluene	0.0003		0.005		--	4,500	8,200
Trichloroethene	0.001		0.01		--	150	310

Sample ID	B20-SIFT16				B20-SIFT16			
Sample Date	03/28/00				04/21/00			
Sample Type	N1				N1			
Soil Type	Soil				Soil			
Beginning Depth	9				9			
Ending Depth	10				10			
Lab ID	AP90423				AP91513			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)								
Barium	**235.32**	**J**	**1**	**1.0**				
Chromium	18.6	F	1	20.0				
Copper	**102.33**	**J**	**1**	**2.0**				
Nickel	10.68	J	1	2.0				
Zinc	**97.86**	**J**	**1**	**2.0**				
SW7060A (mg/kg)								
Arsenic	12.0	J	5	2.5				
SW7131A (mg/kg)								
Cadmium	0.85		5	0.5				
SW7421 (mg/kg)								
Lead	**2,278.26**	**J**	**1000**	**5.0**				
SW7471A (mg/kg)								
Mercury	0.27	J	1	0.1				
SW8260B (mg/kg)								
Methylene chloride					0.0007	U	1	0.005
Toluene					0.0008	F	1	0.005
Trichloroethene					0.002	F	1	0.01

Sample ID	B20-SIFT17				B20-SIFT18				RW-B20-Sift19			
Sample Date	03/28/00				03/28/00				04/21/00			
Sample Type	N1				N1				N1			
Soil Type	Soil				Soil				Soil			
Beginning Depth	1				2				0			
Ending Depth	2				3				0.5			
Lab ID	AP90424				AP90425				Q3521			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)												
Barium	171.24	J	1	1.0	117.18	J	1	1.0	**219.2**		**5**	**5.0**
Chromium	16.9	F	1	20.0	12.3	F	1	20.0	24.1	F	5	100.0
Copper	**66.14**	**J**	**1**	**2.0**	**31.88**	**J**	**1**	**2.0**	**236.6**	**J**	**5**	**10.0**
Nickel	10.6	J	1	2.0	7.17	J	1	2.0	14.6		5	10.0
Zinc	**94.03**	**J**	**1**	**2.0**	42.21	J	1	2.0	**478.5**	**J**	**5**	**10.0**
SW7060A (mg/kg)												
Arsenic	13.1	J	5	2.5	10.9	J	5	2.5	4.9	J	1	0.5
SW7131A (mg/kg)												
Cadmium	0.87		5	0.5	0.6		5	0.5	0.66		1	0.1
SW7421 (mg/kg)												
Lead	65.29	J	50	0.25	**1,627.22**	**J**	**500**	**2.5**	**1,286.**		**1000**	**5.0**
SW7471A (mg/kg)												
Mercury	0.46	J	1	0.1	0.19	J	1	0.1	0.024	U	1	0.1
SW8260B (mg/kg)												
Methylene chloride												
Toluene												
Trichloroethene												

Tables present all laboratory results for analytes detected above the method detection limit.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:32313, 32499
O'Brien and Gere: 5439

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.

--	No risk reduction standard or background level available
Bte	Brackett-Tarrant
Cb	Crawford and Bexar
DL	Dilution
FD1	Field Duplicate
GWP-Ind	Soil MSC based on groundwater protection
Kr	Krum Complex
MDL	Method Detection Limit
N1	Environmental Sample
NA	Not Available
RL	Reporting Limit
SAI-Ind	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL	Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Summary of Chemical Constituents Detected in Sifted Soil, March and April 2000
Solid Waste Management Unit B-20

	Soil Comparison Criteria						
	Lab MDL APPL	Lab MDL OGB	Lab MDL APPL	Lab MDL OGB	Background[a] Soil	TRRP-Tier 1 (Res. $^{Tot}Soil_{Comb}$)	TRRP-Tier 1 (Ind. $^{Tot}Soil_{Comb}$)
SW6010B (mg/kg)							
Barium	0.08	0.04	1.0	1.0	186	2,800	39,000
Chromium	0.10	0.08	20.0	20.0	40.2	30,000	95,000
Copper	0.19	0.07	2.0	2.0	23.2	550	38,000
Nickel	0.12	0.12	2.0	2.0	35.5	840	8,800
Zinc	0.63	0.42	2.0	2.0	43.2	9,900	250,000
SW7060A (mg/kg)							
Arsenic	0.04	0.032	0.5	0.5	19.6	24	200
SW7131A (mg/kg)							
Cadmium	0.01	0.022	0.1	0.1	3	52	8,500
SW7421 (mg/kg)							
Lead	0.13	0.00032	0.5	0.005	84.5	500	1,600
SW7471A (mg/kg)							
Mercury	0.01	0.024	0.1	0.1	0.77	8.3	19
SW8260B (mg/kg)							
Methylene chloride	0.0007		0.005		--	390	960
Toluene	0.0003		0.005		--	4,500	8,200
Trichloroethene	0.001		0.01		--	150	310

Sample ID	RW-B20-Sift20				RW-B20-Sift21				RW-B20-Sift22				RW-B20-Sift23			
Sample Date	04/21/00				04/21/00				04/21/00				04/21/00			
Sample Type	N1				N1				N1				N1			
Soil Type	Soil				Soil				Soil				Soil			
Beginning Depth	0				0				0				0			
Ending Depth	0.5				0.5				0.5				0.5			
Lab ID	Q3522				Q3523				Q3524				Q3525			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/kg)																
Barium	**203.6**		**1**	**1.0**	**314.**		**5**	**5.0**	**205.3**		**1**	**1.0**	**307.**		**5**	**5.0**
Chromium	21.4		1	20.0	23.3	F	5	100.0	22.4		1	20.0	22.7	F	5	100.0
Copper	**98.9**	**J**	**1**	**2.0**	**62.4**	**J**	**5**	**10.0**	**1,267.6**	**J**	**1**	**2.0**	**393.4**	**J**	**5**	**10.0**
Nickel	12.7		1	2.0	13.5		5	10.0	13.2		1	2.0	12.9		5	10.0
Zinc	**102.**	**J**	**1**	**2.0**	**85.1**	**J**	**5**	**10.0**	**96.9**	**J**	**1**	**2.0**	**354.8**	**J**	**5**	**10.0**
SW7060A (mg/kg)																
Arsenic	5.5	J	2	1	5.8	J	2	1	5.4	J	2	1	0.8	J	1	0.5
SW7131A (mg/kg)																
Cadmium	0.52		1	0.1	0.67		1	0.1	0.71		1	0.1	0.7	M	1	0.1
SW7421 (mg/kg)																
Lead	**402.6**		**100**	**0.5**	**159.8**		**100**	**0.5**	**177.4**		**100**	**0.5**	**23,550.**		**10000**	**50.0**
SW7471A (mg/kg)																
Mercury	0.13		1	0.1	0.69		2	0.2	0.09	F	1	0.1	0.07	F	1	0.1
SW8260B (mg/kg)																
Methylene chloride																
Toluene																
Trichloroethene																

Tables present all laboratory results for analytes detected above the method detection limit.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:32313, 32499
O'Brien and Gere: 5439

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.

--	No risk reduction standard or background level available
Bte	Brackett-Tarrant
Cb	Crawford and Bexar
DL	Dilution
FD1	Field Duplicate
GWP-Ind	Soil MSC based on groundwater protection
Kr	Krum Complex
MDL	Method Detection Limit
N1	Environmental Sample
NA	Not Available
RL	Reporting Limit
SAI-Ind	Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL	Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Sample ID						PIMS-NT-0601				PIMS-NT-0601				PIMS-T-0601				PIMS-T-0601				B-20-PIMS-9			
Sample Date						06/21/01				06/21/01				06/21/01				06/21/01				02/27/01			
Sample Type						N1				N1				N1				N1				N1			
Beginning Depth						0				0				0				0				0			
Ending Depth						1				1				1				1				1			
Lab ID						AP19185				AP19185				AP19186				AP19186				AP29849			
	Soil Comparison Criteria																								
	Lab MDL APPL	**Lab MDL APPL**	**Background[a]** Soil	**RRS2-GWP (Ind.)**	**RRS2-SAI (Ind.)**	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/kg)																									
Lead	0.13	0.5	84.1	1.5	1,000	100.12	R	1	0.5	920.27		200	100	116.21	R	1	0.5	384.51	J	100	50	17.31	R	1	0.5
EPA 300.0 (mg/kg)																									
Phosphate	0.84	2.0	NA	NA	NA					0.84	U	1	2					0.84	U	1	2				

Sample ID	B-20-PIMS-9				B-20-PIMS-10				B-20-PIMS-10				B-20-NT-2				B-20-NT-2			
Sample Date	02/27/01				02/27/01				02/27/01				04/11/02				04/11/02			
Sample Type	N1				N1				N1				N1				N1			
Beginning Depth	0				0				0				0				0			
Ending Depth	1				3				3				2				2			
Lab ID	AP29849				AP29850				AP29850				AP31926				AP31926			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/kg)																				
Lead	91,828.04		40000	20000	132.94	R	1	0.5	2,008.56		500	250	33.9	R	1	0.5	123,638.5		25000	12500
EPA 300.0 (mg/kg)																				
Phosphate																				

Tables present all laboratory results for analytes detected above the method detection limit.
Results from all laboratory analysis are presented in Appendix B.
All samples were analyzed by APPL Inc. and O'Brien and Gere Laboratories.
Referenced laboratory package numbers: APPL Inc.:35842, 36138, 37736

All MS/MSD results are presented in the Data Verification Report, Appendix E.

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.

NA Not Applicable
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SAI-Ind Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Sample ID					PIMS-T-0601				B20-PIMS-1				B20-PIMS-1				B20-PIMS-2			
Sample Date					06/21/01				10/10/01				10/10/01				10/10/01			
Sample Type					N1				N1				N1				N1			
Matrix Type					TCLP				TCLP				TCLP				TCLP			
Beginning Depth					0				0				0				0			
Ending Depth					3.				3.				3.				3			
Lab ID					AP19186				AP23202				AP23202				AP23203			
	Waste Characterization Criteria																			
	Lab MDL	Lab RL	Federal Characteristic Hazardous Criteria (mg/L)	Texas Class 1 Non-Hazardous Criteria (mg/L)	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/l)																				
Lead	0.0008	0.005	5	1.5	0.2361		1	0.003	0.2474	R	1	0.005	0.273		10	0.05	0.4431	R	1	0.005

Sample ID	B20-PIMS-2				B20-PIMS-3				B20-PIMS-3				B20-PIMS-4				B20-PIMS-4				B20-PIMS-5			
Sample Date	10/10/01				10/10/01				10/10/01				10/10/01				10/10/01				10/10/01			
Sample Type	N1				N1				N1				N1				N1				N1			
Matrix Type	TCLP				TCLP				TCLP				TCLP				TCLP				TCLP			
Beginning Depth	0				0				0				0				0				0			
Ending Depth	3				3				3				3				3				3			
Lab ID	AP23203				AP23204				AP23204				AP23205				AP23205				AP23206			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/l)																								
Lead	0.5066		20	0.1	0.5891	R	1	0.005	0.8085		20	0.1	0.7592	R	1	0.005	1.2311		50	0.25	0.4175	R	1	0.005

Sample ID	B20-PIMS-5				B20-PIMS-6				B20-PIMS-6				B20-PIMS-7				B20-PIMS-7				B20-PIMS-8				B20-PIMS-8			
Sample Date	10/10/01				10/10/01				10/10/01				10/10/01				10/10/01				10/10/01				10/10/01			
Sample Type	N1				N1				N1				N1				N1				N1				N1			
Matrix Type	TCLP				TCLP				TCLP				TCLP				TCLP				TCLP				TCLP			
Beginning Depth	0				0				0				0				0				0				0			
Ending Depth	3				3				3				3				3				3				3			
Lab ID	AP23206				AP23207				AP23207				AP23208				AP23208				AP23209				AP23209			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW6010B (mg/l)																												
Lead	0.4684		20	0.1	0.2698	R	1	0.005	0.3115		10	0.05	0.1545	R	1	0.005	0.1706		10	0.05	0.1167	R	1	0.005	0.1195		10	0.05

Tables present all laboratory results for analytes detected above the method detection limit.
Results from all laboratory analysis are presented in Appendix A.
All samples were analyzed by APPL Inc.
Referenced laboratory package numbers:APPL, Inc. 36599,

All MS/MSD results are presented in the Data Verification Report, Appendix D.

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed Texas Class 1 Standards.
Boxed samples indicate results greater than Federal Characteristic Hazardous Standards.
-- No risk reduction standard or background level available
DL Dilution
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SQL Sample Quantitation Limit
WG Ground Water

Data Qualifiers:
F- The analyte was positively identified, but the associated numerical value is below the RL.
M - A matrix effect was present.
R - Rejected

Sample ID						PIMS-L1				PIMS-L1				PIMS-L2-1				PIMS-L2-1			
Sample Date						07/09/01				07/09/01				08/14/01				08/14/01			
Sample Type						N1				N1				N1				N1			
Matrix Type						WG				WG				WG				WG			
Filter size						0.45 microns				0.45 microns				0.45 microns				0.45 microns			
Lab ID						AP19187				AP19187				AP20953				AP20953			
	Lab MDL APPL	Lab MDL APPL	Federal Maximum Contaminat Level (MCL)	RRS2-GWP (Ind.)	RRS2-SAI (Ind.)	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																					
Lead	0.0008	0.005	0.0015	1.5	1,000	0.2687	R	1	0.005	0.3473		20	0.1	0.0918	R	1	0.005	0.1012	J	20	0.1
SW6010B (mg/kg)																					
Barium																					
Chromium																					
Copper																					
Nickel																					
Zinc																					
SW7060A (mg/kg)																					
Arsenic																					
SW7131A (mg/kg)																					
Cadmium																					
SW7471A (mg/kg)																					
Mercury																					

Sample ID	PIMS - L2-2				PIMS Leachate				PIMS - L3				PIMS L3-1				PIMS L3-2			
Sample Date	08/14/01				10/23/01				12/19/01				02/27/02				02/27/02			
Sample Type	N1				N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG				WG			
Filter size	0.10 microns				0.45 microns				0.45 microns				0.45 microns				0.10 microns			
Lab ID	AP20954				AP23897				AP26781				AP29847				AP29847			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																				
Lead	0.0036	F	1	0.005	0.0032	U	40	0.2	0.0022	F	1	0.005	0.0077		1	0.005	0.0039	F	1	0.005
SW6010B (mg/kg)																				
Barium																				
Chromium																				
Copper																				
Nickel																				
Zinc																				
SW7060A (mg/kg)																				
Arsenic																				
SW7131A (mg/kg)																				
Cadmium																				
SW7471A (mg/kg)																				
Mercury																				

Sample ID	B-20-L2-1.45				B20-L3-1.45				B20-L3-1.10				B20-L1-2.45			
Sample Date	04/11/02				04/11/02				04/11/02				06/30/02			
Sample Type	N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG			
Filter size	0.45 microns				0.45 microns				0.10 microns				0.45 microns			
Lab ID	AP31923				AP31924				AP31925				AP35876			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																
Lead	0.0066		1	0.005	0.005		1	0.005	0.0014	F	1	0.005	0.0008	U	1	0.005
SW6010B (mg/kg)																
Barium													1.9684		1	0.005
Chromium													0.003	F	1	0.005
Copper													0.069		1	0.005
Nickel													0.015		1	0.005
Zinc													0.05		1	0.005
SW7060A (mg/kg)																
Arsenic													0.005		1	0.005
SW7131A (mg/kg)																
Cadmium													0.0001	U	1	0.005
SW7471A (mg/kg)																
Mercury													0.0001	U	1	0.005

Tables present all laboratory results for analytes detected above the method detection limit.
Results from all laboratory analysis are presented in Appendix B.
All samples were analyzed by APPL Inc.
Referenced laboratory package numbers: APPL Inc.:35842, 36138, 37736

All MS/MSD results are presented in the Data Verification Report, Appendix E.

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.
NA Not Applicable
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SAI-Ind Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Sample ID	Lab MDL APPL	Lab MDL APPL	Federal Maximum Contaminat Level (MCL)	RRS2-GWP (Ind.)	RRS2-SAI (Ind.)	B20-L2-2.45				B20-L2-3.45				B20-L3-3.45			
Sample Date						06/30/02				07/10/02				07/10/02			
Sample Type						N1				N1				N1			
Matrix Type						WG				WG				WG			
Filter size						0.45 microns				0.45 microns				0.45 microns			
Lab ID						AP35877				AP35874				AP35875			
						Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																	
Lead	0.0008	0.005	0.0015	1.5	1,000	0.0008	U	1	0.005	0.0035	F	1	0.005	0.0054		1	0.005
SW6010B (mg/kg)																	
Barium						1.252		1	0.005	4.1442		5	0.025	0.6227		1	0.005
Chromium						0.001	U	1	0.005	0.001	U	1	0.005	0.001	U	1	0.005
Copper						0.045		1	0.005	0.122		1	0.005	0.031		1	0.005
Nickel						0.008	F	1	0.005	0.02		1	0.005	0.005	F	1	0.005
Zinc						0.034	F	1	0.005	0.135		1	0.005	0.034	F	1	0.005
SW7060A (mg/kg)																	
Arsenic						0.0091		1	0.005	0.0076		1	0.005	0.0124		1	0.005
SW7131A (mg/kg)																	
Cadmium						0.0003	F	1	0.005	0.0002	F	1	0.005	0.0003	F	1	0.005
SW7471A (mg/kg)																	
Mercury						0.0001	U	1	0.005	0.0002	F	1	0.005	0.0001	U	1	0.005

Sample ID	B20-L1-4.1				B20-L2-4.1				B20-L3-4.1				B20-L1-5.45			
Sample Date	08/21/02				08/21/02				08/21/02				10/26/02			
Sample Type	N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG			
Filter size	0.1 microns				0.1 microns				0.1 microns				0.45 microns			
Lab ID	AP37774				AP37775				AP37776				AP40715			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																
Lead	0.0014	F	1	0.005	0.0043	F	1	0.005	0.0016	F	1	0.005	0.0027	F	1	0.005
SW6010B (mg/kg)																
Barium	0.4162		1	0.005	0.0463		1	0.005	0.3076		1	0.005				
Chromium	0.001	U	1	0.005	0.002	F	1	0.005	0.001	U	1	0.005				
Copper	0.039		1	0.005	0.011		1	0.005	0.026		1	0.005				
Nickel	0.006	F	1	0.005	0.003	F	1	0.005	0.005	F	1	0.005				
Zinc	0.021	F	1	0.005	0.033	F	1	0.005	0.019	F	1	0.005				
SW7060A (mg/kg)																
Arsenic	0.001	F	1	0.005	0.0013	U	1.6667	0.00833	0.0024	F	1	0.005				
SW7131A (mg/kg)																
Cadmium	0.0002	F	1	0.005	0.0003	F	1	0.005	0.0001	U	1	0.005				
SW7471A (mg/kg)																
Mercury																

Sample ID	B20-L2-5.45				B20-L3-5.45				B20-L4-5.45				B20-L4-5.45			
Sample Date	10/26/02				10/26/02				10/26/02				10/26/02			
Sample Type	N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG			
Filter size	0.45 microns				0.45 microns				0.45 microns				0.45 microns			
Lab ID	AP40716				AP40717				AP40718				AP40718			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)																
Lead	0.0062		1	0.005	0.0022	F	1	0.005	0.2881	R	1	0.005	0.3937		10	0.05
SW6010B (mg/kg)																
Barium									12.1852	R	1	0.005	15.5902	J	20	0.1
Chromium									0.004	F	1	0.005				0
Copper									0.081		1	0.005				0
Nickel									0.005	F	1	0.005				0
Zinc									0.096		1	0.005				0
SW7060A (mg/kg)																
Arsenic									0.0008	J	1	0.005				0
SW7131A (mg/kg)																
Cadmium									0.0003	F	1	0.005				0
SW7471A (mg/kg)																
Mercury									0.0001	U	1	0.005				

Sample ID	B20-L1-6.45				B20-L1-6.1			
Sample Date	12/21/02				12/21/02			
Sample Type	N1				N1			
Matrix Type	WG				WG			
Filter size	0.45 microns				0.1microns			
Lab ID	AP43112				AP43113			
	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
SW7421 (mg/L)								
Lead	0.0008	U	1	0.005	0.0008	U	1	0.005
SW6010B (mg/kg)								
Barium	1.7758		1	0.005	1.7973		1	0.005
Chromium	0.001	U	1	0.005	0.003	F	1	0.005
Copper	0.038		1	0.005	0.039		1	0.005
Nickel	0.007	F	1	0.005	0.008	F	1	0.005
Zinc	0.031	F	1	0.005	0.028	F	1	0.005
SW7060A (mg/kg)								
Arsenic	0.0008	U	1	0.005	0.0008	U	1	0.005
SW7131A (mg/kg)								
Cadmium	0.0001	U	1	0.005	0.0001	U	1	0.005
SW7471A (mg/kg)								
Mercury								

Tables present all laboratory results for analytes detected above the method detection limit.
Results from all laboratory analysis are presented in Appendix B.
All samples were analyzed by APPL Inc.
Referenced laboratory package numbers: APPL Inc.:35842, 36138, 37736

All MS/MSD results are presented in the Data Verification Report, Appendix E.

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.
NA Not Applicable
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SAI-Ind Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

	Lab MDL APPL	Lab MDL APPL	Federal Maximum Contaminat Level (MCL)	RRS2-GWP (Ind.)	RRS2-SAI (Ind.)	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
Sample ID						B20-L2-6.45				B20-L2-6.1				B20-L3-6.45			
Sample Date						12/21/02				12/21/02				12/21/02			
Sample Type						N1				N1				N1			
Matrix Type						WG				WG				WG			
Filter size						0.45 microns				0.1 microns				0.45 microns			
Lab ID						AP43114				AP43115				AP43116			
SW7421 (mg/L)																	
Lead	0.0008	0.005	0.0015	1.5	1,000	0.0008	U	1	0.005	0.0031	F	1	0.005	0.0008	U	1	0.005
SW6010B (mg/kg)																	
Barium						0.6582		1	0.005	0.5903		1	0.005	0.5548		1	0.005
Chromium						0.004	F	1	0.005	0.001	U	1	0.005	0.001	U	1	0.005
Copper						0.038		1	0.005	0.036		1	0.005	0.019		1	0.005
Nickel						0.007	F	1	0.005	0.006	F	1	0.005	0.003	F	1	0.005
Zinc						0.031	F	1	0.005	0.03	F	1	0.005	0.02	F	1	0.005
SW7060A (mg/kg)																	
Arsenic						0.0008	U	1	0.005	0.0008	U	1	0.005	0.0008	U	1	0.005
SW7131A (mg/kg)																	
Cadmium						0.0001	U	1	0.005	0.0003	F	1	0.005	0.0001	U	1	0.005
SW7471A (mg/kg)																	
Mercury																	

	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
Sample ID	B20-L3-6.1				B20-L4-6.45				B20-L4-6.45				B20-L4-6.1				B20-L4-6.1			
Sample Date	12/21/02				12/21/02				12/21/02				12/21/02				12/21/02			
Sample Type	N1				N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG				WG			
Filter size	0.1 microns				0.45 microns				0.45 microns				0.1 microns				0.1 microns			
Lab ID	AP43117				AP43118				AP43118				AP43119				AP43119			
SW7421 (mg/L)																				
Lead	0.0008	U	1	0.005	0.2872	R	1	0.005	0.3512		10	0.05	0.0924	R	1	0.005	0.0906		5	0.025
SW6010B (mg/kg)																				
Barium	0.5337		1	0.005	11.3676	R	1	0.005	11.065		10	0.05	11.6539	R	1	0.005	11.471		10	0.05
Chromium	0.001	U	1	0.005	0.001	U	1	0.005				0	0.002	F	1	0.005				0
Copper	0.019		1	0.005	0.077		1	0.005				0	0.074		1	0.005				0
Nickel	0.003	F	1	0.005	0.004	F	1	0.005				0	0.008	F	1	0.005				0
Zinc	0.021	F	1	0.005	0.046	F	1	0.005				0	0.059		1	0.005				0
SW7060A (mg/kg)																				
Arsenic	0.0008	U	1	0.005	0.0008	U	1	0.005				0	0.0008	U	1	0.005				0
SW7131A (mg/kg)																				
Cadmium	0.0001	U	1	0.005	0.0001	U	1	0.005				0	0.0002	F	1	0.005				0
SW7471A (mg/kg)																				
Mercury																				

	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL	Results	Flags	Dilution	SQL
Sample ID	B10-17				B20-L1-7.45				B20-L2-7.45				B20-L3-7.45				B10-16			
Sample Date	04/10/03				04/10/03				04/10/03				12/21/02				04/10/03			
Sample Type	N1				N1				N1				N1				N1			
Matrix Type	WG				WG				WG				WG				WG			
Filter size	0. microns				0.45 microns				0.45 microns				0.45 microns				0. microns			
Lab ID	AP48602				AP48599				AP48600				AP48601				AP48602			
SW7421 (mg/L)																				
Lead				0	0.0065		1	0.005	0.0035	F	1	0.005	0.0008	U	1	0.005	1.27		1	0.005
SW6010B (mg/kg)																				
Barium				0				0				0				0				0
Chromium				0				0				0				0				0
Copper				0				0				0				0				0
Nickel				0				0				0				0				0
Zinc	0.63	J	1	0.005				0				0				0				0
SW7060A (mg/kg)																				
Arsenic				0				0				0				0				0
SW7131A (mg/kg)																				
Cadmium				0				0				0				0				0
SW7471A (mg/kg)																				
Mercury																				

Tables present all laboratory results for analytes detected above the method detection limit.
Results from all laboratory analysis are presented in Appendix B.
All samples were analyzed by APPL Inc.
Referenced laboratory package numbers: APPL Inc.:35842, 36138, 37736

All MS/MSD results are presented in the Data Verification Report, Appendix E.

Abbreviations and Notes:
Highlighted and bolded sample concentrations exceed RRS1 and RRS2 Standards.
Boxed samples indicate results greater than RRS2 Standards.
NA Not Applicable
MDL Method Detection Limit
N1 Environmental Sample
NA Not Available
RL Reporting Limit
SAI-Ind Soil MSC for industrial use based on inhalation, ingestion, and dermal contact .
SQL Sample Quantitation Limit

Data Qualifiers:
F- The analyte was positively identified but the associated numerical value is below the RL..
M - A matrix effect was present.
U - The analyte was analyzed for, but not detected. The associated numerical value is the MDL..

Appendix B
Analytical Methods Supporting the Sampling Plan

The analytical methods anticipated for supporting the sampling plan of the PIMS field demonstration include:

- USEPA Solid Waste (SW) - 846 method 6010B (ICP barium, chromium, copper, nickel, and zinc)
- USEPA SW-846 method 7421 (GFAA lead)
- USEPA SW-846 Method 7131A (GFAA cadmium)
- USEPA SW-846 Method 7060A (GFAA arsenic)
- USEPA SW-846 Method 7471A (Cold vapor mercury)
- USEPA SW-846 method 1311 (TCLP extraction)
- USEPA SW-846 Method 1312 (SPLP extraction)

Appendix C
Sampling and Analysis Plan

TABLE OF CONTENTS

Page

FIGURES

Page

TABLES

Page

ACRONYMS AND ABBREVIATIONS

AC	Alternating current
AFCEE	Air Force Center for Environmental Excellence
AFCEE/ERD	Air Force Center for Environmental Excellence/Environmental Restoration Division
AIHA	American Industrial Hygiene Association
AMC	Air Mobility Command
ASTM	American Society for Testing and Materials
bgl	Below ground level
BTEX	Benzene, toluene, ethyl benzene, and xylenes
^oC	Degrees Celsius
cm	centimeter
COC	Chain of custody
CSSA	Camp Stanley Storage Activity
DCE	Dichloroethene
DE	Decontamination equipment
DOT	US Department of Transportation
EB	Equipment blank
ECD	Electron-capture detector
EMI	Electromagnetic induction
EPA	US Environmental Protection Agency
eV	Electron volt
^oF	Degrees Fahrenheit
FSP	Field sampling plan
GC	Gas chromatograph
GPS	Global positioning system
GW	Groundwater sample
HASP	Health and safety plan
HNO_3	Nitric acid
IDW	Investigation-derived waste
IRP	Installation Restoration Program
LEL	Lower explosive limit
MeV	Million electron volts
MS	Matrix spike
mS/cm	MilliSemiens per centimeter
MSD	Matrix spike duplicate
mg/L	Milligrams per liter
mg/cm^2	Milligrams per centimeter squared
µmhos/cm	Micromhos per centimeter
N/A	Not applicable
NIOSH	National Institute for Occupational Safety and Health
OVA	Organic vapor analyzer
Parsons ES	Parsons Engineering Science, Inc.

ACRONYMS AND ABBREVIATIONS, continued

PCE	Tetrachloroethene
PEL	Permissible exposure limit
PID	Photoionization detector
POC	Point of contact
PPE	Personal protective equipment
ppm	Parts per million
PVC	Polyvinyl chloride
QA	Quality assurance
QC	Quality control
QAPP	Quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial investigation/feasibility study
SAP	Sampling analysis plan
SB	Soil boring sampling location
SS	Surface soil sampling location
SVOA	Semivolatile organic analyses
SVOC	Semivolatile organic compound
SW	Surface water sampling location
SWMU	Solid waste management unit
TB	Trip blank
TCE	Trichloroethene
TCLP	Toxicity characteristic leaching procedure
TNRCC	Texas Natural Resource Conservation Commission (formerly TWC)
USCS	Unified Soil Classification System
VOA	Volatile organic analyses
VOC	Volatile organic compound
WP	Work plan
WWTP	Wastewater treatment plant

SECTION 1
INTRODUCTION AND FIELD OPERATIONS

This document presents the field sampling plan (FSP) in support of investigation and closure of the listed solid waste management units (SWMUs) at Camp Stanley Storage Activity (CSSA), Texas. This FSP describes specific closure activities anticipated to be necessary to satisfy regulatory requirements for closure of the SWMUs identified in this plan. The CSSA EPA identification number is TXD2210020739, and its Texas solid waste registration number is 69026.

This document was prepared by Parsons Engineering Science, Inc. (Parsons ES) of Austin, Texas, for CSSA under the U.S. Air Force Air Mobility Command (AMC) Contract F11623-94-D0024, delivery order RL 17.

This field sampling plan describes the scope and procedure for field sampling activities and is organized into five sections. The first section includes details of planned field operations. Environmental sampling procedures are presented in Section 2. Section 3 details field measurements. Section 4 describes field quality assurance/quality control (QA/QC). References are in Section 5.

1.1 FIELD OPERATIONS

The primary purpose of this field investigation is to obtain data sufficient to assess the closure potential of each of eight low priority units, thirteen medium priority units, and seven high priority units located at CSSA. Approximate SWMU sites are on map 1 in Appendix A. The work plan (WP) details the work to be performed and presents location maps of each SWMU. The project objectives will be accomplished by conducting a field investigation under procedures which are outlined in this FSP. Each SWMU will be located and mapped, followed by surface collection of soil samples for analyses and evaluation. If surface soils are found to be contaminated, or subsurface waste management actions are suspected, or geophysical anomalies are identified through a surface geophysical survey, shallow borings will be drilled. If water is present in the shallow borings, groundwater samples will be at the unsaturated-saturated interface collected for specific chemical analysis. If contamination is suspected, a grab sample of groundwater may be collected. If these samples indicate contamination, borings will be completed as monitoring wells and groundwater samples collected. In addition, soil gas surveys will be conducted in specified areas.

The field procedures described in this section were developed to incorporate standard procedures, such as those in the U.S. EPA *Compendium of Superfund Field Operations Methods* (EPA, 1987), the Air Force Center for Environmental Excellence

(AFCEE) *Handbook for the Installation Restoration Program (IRP)* (AFCEE, 1993), and Parsons ES's Field Services Manual, (Engineering-Science, 1992).

Standard forms will be used for documentation of borehole logging, monitoring well construction, most field sampling operations, and equipment calibration. Bound field logbooks will be used to record daily field activities and events. Procedures for logbook documentation are presented in Section 4.4 and examples of standard forms to be used are located in Appendix A.

1.1.1 Site Reconnaissance, Preparation, and Restoration Procedures

The SWMU sites at CSSA were categorized as low, medium, and high priority sites based on past waste management practices. The minimal field investigations for the low priority units will include mapping, geophysical surveys, and sampling at least three surface soil locations. However, unless field conditions indicate otherwise, these investigations will probably not include subsurface investigation or water samples. Geophysical surveys and at least three soil borings will be completed at all thirteen medium priority sites. Three samples will be taken from each soil boring area; at surface, middle, and total depths. If groundwater is encountered in a particular soil boring, the saturated/unsaturated interface in that boring will be sampled. If the sample is discovered to be contaminated, the boring will be completed and sampled as a groundwater monitoring well. The procedure and criteria for well development is described in Section 1.2.2. Additional closure activities may be performed for the remaining high priority SWMUs based on schedule and budget constraints.

The exact locations of boreholes will be determined in the field by Parsons ES personnel prior to investigation. Underground and aboveground utility lines, buildings, and natural features will be considered in choosing these drilling locations. The drilling locations will be submitted to CSSA and AFCEE for approval prior to initiating any investigative efforts. Ambient air conditions will be monitored for organic vapors before and periodically during drilling to ensure that no health and safety concerns exist at the site. Plugging the boreholes is further discussed in Section 1.3.

A temporary field office will be located at CSSA to store field team equipment and recharge project equipment. A fire extinguisher and first aid kit will be available in the field office and in each field vehicle for transport to each site where field activities are being performed. All other personal safety equipment such as protective clothing and respirators will be stored in the field office. All hazardous chemicals will be stored in a fire-resistant cabinet. The *Health and Safety Plan* (HASP) *for Closure of SWMUs at Camp Stanley Storage Activity, Boerne, Texas* may be referred to for further information on health and safety issues (Parsons ES, 1995).

Decontamination of equipment used during the investigation will take place at decontamination areas set up specifically for this purpose. Decontamination fluids will be containerized at each site until laboratory results for that site are received and are evaluated for the possibility of contamination. If analytical results indicate

contamination, the decontamination fluids will be characterized for appropriate disposal. Contaminated fluids will also be containerized and subsequently characterized for disposal in accordance with applicable laws and regulations. Parsons ES will assist CSSA in planning the disposal of waste materials and fluids which cannot be treated at CSSA. Section 1.7 of this plan outlines the management of investigation-derived wastes (IDWs).

Efforts will be made to minimize disturbance at all field activity sites. All trash associated with this investigation will be removed from the site and all landscaped sites will be restored to their original conditions.

1.1.2 Surface Geophysical Surveys

The surface geophysical surveys will be conducted using an Geonics™ EM-31 electromagnetic instrument. In the electromagnetic induction (EMI) method, the electrical conductivity of a geohydrologic section is measured by transmitting a high-frequency electromagnetic field into the earth, producing eddy currents that generate secondary electromagnetic fields which can be detected by a receiver. The eddy currents are induced in the earth by an aboveground transmitter coil, and the resulting secondary electromagnetic fields are coupled to an aboveground receiver coil. Thus, EMI measurements do not require direct ground contact as is the case for resistivity measurement, allowing surveys along traverse or specific areas to be performed rapidly.

1.1.2.1 Determination of Electromagnetic Measurement Locations

Electromagnetic conductivity measurements are generally collected along a grid system. The area covered by the grid and the spacing between grid nodes is site-specific and depends on the project objectives. The maximum grid spacing will be no larger than 100 feet by 100 feet, with data points spaced every two feet along each grid line. Gridlines will be spaced every 20 to 50 feet and will be site-specific. CSSA and AFCEE personnel will approve all proposed grids prior to surveying activities.

The first step is to establish a base, or background, station to measure the naturally occurring electromagnetic properties in the site vicinity. The base station will be selected to represent naturally existing subsurface conditions at the site.

Background readings will be taken periodically during the electromagnetic conductivity survey. The readings will be taken daily before the survey begins, at 2-hour intervals during the survey, and at the end of each day's work.

The most recent portion of the electromagnetic conductivity survey will be repeated if the base station readings vary by more than 20 percent. The base station readings should be stable unless electronic interference is occurring or unless heavy rains increase the soil saturation.

Data will be continuously recorded with a digital data logger (polycorder). For each survey line, the line number, starting point, direction of traverse, and increment of

measurement will be entered in the polycorder. This information will also be recorded in the field logbook, as well as the ending point. Cross-checks will be made between the logbook and polycorder for each line to ensure correct identification and settings. If a discrepancy is found, the survey team will return to the last verified grid point or line and continue forward with the survey.

Data will be collected in both quadrature and in-phase modes. The quadrature mode is generally more useful for investigating the limits of disturbed soil as it allows detection of subtle differences in areal ground conductivity. The in-phase mode is less sensitive and generally more adept for use in locating metal objects.

The data will be plotted upon completion of the survey and before demobilizing to determine if the survey data is valid and the coverage of the site is complete. Additional data will be obtained as needed to complete the survey.

1.1.2.2 Equipment Functional Checks

The range switch should be set at the 30 milliSiemens/centimeter (mS/cm) position for these tests. If the reading is off scale, i.e., greater than 30 mS/cm, refer to the note at the end of this section.

a) Set the mode switch to the "Comp" position and adjust the meter reading to zero using the coarse and fine compensation controls.

b) To check the phasing of the instrument, set the mode switch to the "Phase" position. Note the meter readings and rotate the coarse control one step clockwise. If the meter reading remains the same, the phasing is correct. Return the coarse control to its original position (one step counterclockwise); no further adjustment is necessary.

A phase adjustment is required if there is a difference in the meter readings taken before and after the coarse control was rotated one step clockwise. With the coarse control in its original position, adjust the phase potentiometer about one-quarter turn clockwise and note the new meter reading. Rotate the coarse control one step clockwise, take a reading, and return the coarse control to its original position. If the difference in meter readings has decreased, repeat the procedure using a further clockwise adjustment until rotating the coarse control one step clockwise produces no change in the meter reading. However, if the difference in meter readings was increased, the phase potentiometer should be rotated in a counterclockwise direction instead, and the procedure described above repeated until there is no change in the meter readings. Always remember to set the coarse control back to its original position. This can be confirmed by setting the mode switch in the "Comp" position and checking to see that the meter reads zero. If it does not read zero, repeat steps (a) and (b).

c) To check the sensitivity of the instrument, set the mode switch to the "Comp" position and rotate the coarse control clockwise one step. The meter should read between 75 and 85 percent (22 to 26 mS/cm) of full-scale deflection (inside black

mark). It is unlikely that the sensitivity of the instrument will vary; however, it may be useful to record the actual meter reading for comparison at a later date.

Return the coarse switch to its original position; the instrument is now ready to make ground conductivity measurements. Note that when conducting the functional tests over ground of higher conductivity than 30 mS/cm, the range switch should be set at the appropriate level. No matter what level the range switch is in, the readings taken in (c) should still be between 22 and 26 mS/cm.

1.1.2.3 Instrument Calibration

The electromagnetic conductivity meter is internally calibrated at the factory. However, the following instrument checks should be made daily before the electromagnetic conductivity meter is used.

a) Select the transmitter coil tube using the identifying labels on the tubes. Align with respect to the main tube. Insert and clamp the coil in position.

b) Check the battery condition, plus and minus, by setting the mode switch (mode selector switch) to the "Oper" position and the range switch to the "+B" and "-B" positions, respectively. If the needle remains inside the "Batt" mark on the meter, the batteries are in good condition. Otherwise, replace the batteries with a fresh set of C-size alkaline batteries.

c) Check the zero readings by setting the mode switch to the "Oper" position and the range switch to the least sensitive position of 1,000 milliSiemens/ cm. This minimizes any external noise interference while checking the zero position. If a zero adjustment is required, adjust the DC zero control located under the front panel to obtain a zero reading. To do this, the battery pack must be removed to gain access to the controls.

d) Align and connect the receiver coil tube to the main frame tube. The instrument is now ready to proceed with the functional checks.

1.1.3 Soil Gas Survey Methods

A summary of the soil gas survey methods, from determination of sampling locations through sample analysis and quality control procedures, is presented in the following subsections.

1.1.3.1 Determination of Soil Gas Sampling Locations and Sample Depth

Depending on the size of the SWMU to be investigated, soil gas samples will be collected on 20 to 100-foot grid intervals which will be extended off of existing soil gas and geophysical grids from previous investigations or staked out in new areas of concern. If new gridlines are to be established, CSSA and AFCEE concurrence will be obtained. The grid systems used will be shown on individual site base maps.

To determine the optimum sampling depth at each site, depth profiles will be attempted. Because of the variable nature of the soil cover at each site and the proximity

of the underlying limestone to ground surface, sampling at a uniform depth is not practical. Consequently, probes will be generally driven to the bedrock-soil interface or until refusal.

1.1.3.2 Soil Gas Sampling Method

Samples will be collected by manually driving a decontaminated ¾-inch stainless steel hollow sampling rod to the selected depth with a pneumatic hammer. The sampling rod will then be backed a few inches out of the ground allowing the detachable point to drop off the sampling probe and exposing a void space of the formation. Soil vapors will then be pulled from the soil through the probe into a Tedlar™ bag using a portable vacuum pump. The soil formation around the sample rod will be purged for at least three probe volumes prior to sample collection.

The procedure for collection of soil gas samples using Tedlar™ bags is as follows:

1) After purging is completed, the desiccator will be opened and a Tedlar™ bag connected to the line from the sampling probe with a piece of Tygon™ tubing. The top of the desiccator is then put back in place.
2) The vacuum pump will withdraw soil gas from the ground.
3) After a sample has been collected, the bag will be removed from the desiccator, and the valve on the bag closed.

The samples will then be transported to the field gas chromatograph (GC) temporarily located at CSSA for analysis. Samples will be analyzed within four hours of collection.

After sampling, probes will be decontaminated for use at another location. Decontamination procedures consist of washing off the probes with Alconox™ and water, rinsing and allowing the probes to air dry.

1.1.3.3 Soil Gas Sample Screening

An initial screening of the soil gas samples will be performed in the field by scanning the exhaust from the vacuum pump with an explosimeter for oxygen content. The vacuum pump is a rotary vane, oil-less, 1/6 horsepower model equipped with a vacuum regulator. An Industrial Scientific Corporation, Model HMX 271™ will be used to measure the levels of oxygen and explosive gases in the soil gas.

The explosimeter will be calibrated daily for oxygen readings by setting the readout to 20.9 percent oxygen when held in ambient air. For oxygen and LEL measurements, the explosimeter has a stated accuracy of $\pm$ 1.2 percent oxygen by volume in the range of 5-30 percent and $\pm$ 10 percent of the actual concentrations in the range of 30-100 percent of the LEL.

1.1.3.4 Soil Gas Analytical Equipment

Soil gas samples will be analyzed with an HNu™ model 321 GC equipped with an electron-capture detector (ECD) and a photoionization detector (PID) with a 10.2 eV light source. A Spectra-Physics model 4400 dual-channel integrator will be used to plot the chromatograms, to measure the size of the peaks, and to compute compound concentrations.

The ECD contains a radioactive nickel-63 foil with a source strength of 5 millicuries. This source decays by emitting beta particles at a maximum energy of 0.063 million electron volts (MeV) and are absorbed by less than 1 milligram per centimeter squared (mg/cm^2) of aluminum. There is no discernible radiation from the nickel-63 source external to the detector chamber and no hazard as long as the chamber integrity is not violated. A current leak test certification will be maintained on site. The shipment of the ECD to and from the site shall comply with DOT regulations. The instrument is operated under a general license for radioactive sources.

The chromatographic column used for analysis is a 12-foot long, 1/8-inch diameter stainless steel packed column containing 3 percent OV-101 Chromosorb W-HP packing material with a 100/120 mesh particle size. The OV-101 Chromosorb W-HP is the column packing material that performs the actual separation of compounds. This column was selected for use since it is able to separate the compounds targeted for analysis and allows for a relatively rapid analysis time.

1.1.3.5 Target Compounds and Calibration

Soil gas samples will be analyzed for select volatile organic compounds (VOC) including trichloroethene (TCE), tetrachloroethene (PCE), and *cis* and *trans*-1,2-dichloroethene (DCE) because these compounds have been detected in Well 16 and other monitoring wells. In addition, soil gas samples will also be analyzed for benzene, toluene, ethylbenzene, and total xylenes, (BTEX), to test for fuel contamination.

In addition to the above compounds, the total volatile hydrocarbon concentration will be reported. The total hydrocarbon concentration is defined as the sum of all peak areas on the chromatogram through *ortho*-xylene minus any halocarbon peak areas, divided by the toluene response factor and the injection volume. Halocarbons are defined as chlorine, fluorine, or bromine substituted hydrocarbons and include compounds like TCE and PCE.

Calibration standards will be performed at the beginning and end of each day to determine the response factor and retention time for each of the target compounds. The standards will be injected directly into the gas chromatograph in the same manner as the soil gas samples.

1.1.4 Borehole Drilling and Soil Sampling

Borings will be drilled through unconsolidated soils using hollow-stem augers. The boreholes drilled will have an 8-inch diameter to allow for well installation should groundwater be encountered. Borings will be continuously sampled during augering using a decontaminated sampling device (i.e. Shelby tube, split spoon) advanced beyond the lead auger to collect undisturbed soil.

At the point of auger refusal, i.e. bedrock is encountered, borings will be completed by air rotary drilling. During air rotary, samples will be collected using a 5-ft or 10-ft core barrel. The length of the core barrel will be determined by the on-site scientist/engineer based on sample recovery and schedule considerations.

Some lithologies, such as clay infillings, soft marl layers, and solution cavities, have low recovery using air core sampling techniques. Therefore, the on-site scientist/engineer may choose to cease air coring if these lithologies are encountered, and collect samples from the layer using a split spoon or Shelby tube to enhance recovery.

Soil borings will be drilled to a depth of at least 5 feet deeper than observed waste management activity, or if no waste management activity is evident, 5 feet into bedrock. Borings may be advanced deeper if field screening indicated gross contamination at this depth, or if the presence of groundwater dictates advancement for proper monitoring well construction.

If water is not encountered, the borings will be grouted to the surface with a mixture of type I or II Portland cement, bentonite powder, and water in the proportion of 8 gallons of potable water, 4 pounds of bentonite, and 94 pounds (one sack) of cement. Grout will be pumped from the bottom of the borehole upward through a tremie pipe. These procedures are further detailed in Section 1.3.

Additives, except for water, will not be used for dust control or cuttings removal. Only Teflon™ tape, or other lubricants approved by AFCEE will be used on the threads of downhole drilling equipment. Commercial products such as Well Guard, Pure Gold Lube, and Green Stuff, are commonly used for drilling operations. A material safety data sheet for each product that may be used will be provided to AFCEE and CSSA prior to drilling. Additives containing lead or copper shall not be used. The least amount of lubricant necessary shall be applied. These precautions shall preclude residual groundwater sample contamination caused by the lubrication of the downhole equipment.

Actual depths of samples taken for chemical analyses will be at the discretion of the qualified on-site scientist/engineer based on field screening methods, presence of absence of groundwater, total depth of boring, and sample recovery. As many as three soil samples may be collected from each borehole, including samples from the total depth of the boring, at the depth indicated by field screening to be the most contaminated, and at the depth just above and at the saturated zone, if groundwater is encountered. In addition, a soil sample may be collected from the surface (0 to 2 ft bgl) for risk

assessment purposes. Soil samples taken for chemical analyses will be described using Unified Soil Classification System (USCS) terminology. All soil samples will be described by a qualified scientist or engineer with respect to lithology, grain size, color, moisture content, etc. (see Section 1.1.6). In addition, any discoloration of the soil samples or odors detected will be recorded on the boring logs. After they have been lithologically described on the boring logs, the soil or rock samples will be placed into appropriate sample jars and properly labeled. A geologist will be present and responsible at each operating drill rig for logging samples, monitoring drilling operations, recording water losses or gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures. Each geologist will be responsible for only one operating rig and will have, as a minimum, a copy of the WP, SAP, and the HASP. They will also have on-site their own 10X hand lens, weighted steel tape, water level measuring device, and the necessary materials to decontaminate the water level measuring device.

The sample containers will be placed on ice in coolers until delivered to the laboratory. Samples will be shipped to the laboratory on a daily basis. Summaries of the analytical methods, sample containers, and preservatives are presented in Section 2.2.

During drilling activities, if gross contamination or unexploded ordnance is encountered, STOP WORK. Examples of gross contamination are liquid volatile waste or sludges, buried drums or canisters, or other field evidence that the field team leader deems as gross contamination. The field condition will be discussed with the Parsons ES project manager, AFCEE and CSSA prior to resuming work. Because none of the SWMUs undergoing investigation have a history of use as ordnance demolition or storage, and geophysical surveys will be conducted prior to any drilling actions, unexploded ordnance would be highly unlikely to be encountered during drilling. However, if unexploded ordnance is suspected, the field conditions and materiels found (if any) will be discussed with AFCEE, CSSA, and unexploded ordnance specialists before any field work resumes.

1.1.5 Field Screening During Drilling and Sampling

Sampling operations will be monitored using an HNu™ PID to detect the presence of VOCs. The HNu™ PID, which will be calibrated at least once daily according to the manufacturer's specifications, will be used as an indicator of the presence of significant organic vapor levels. During drilling events, samples will be chosen for organic vapor headspace analysis based on instrument scanning and/or qualitative indications of contamination. A representative portion of each sampling interval will be placed in a glass jar for headspace analysis. The analysis will be conducted by securely placing oil-free aluminum foil over the top of the jar, setting the jar aside for 10 to 20 minutes at 70°F to 90°F to allow volatiles to escape from the soil sample into the head space, and then inserting the probe of the HNu™ through the foil to measure the level of VOCs in the headspace of the jar. Organic headspace analysis results will be recorded on the drilling log.

In addition to VOC monitoring, an HMX 271 combustible gas indicator will be used to monitor the lower explosive limit (LEL) in work areas. During field activities that can potentially generate sparks, such as drilling, the breathing zone and the air in and around the borehole or well will be periodically monitored with the HMX 271 combustible gas indicator. Monitored readings will be recorded in the field logs.

During drilling operations, headspace analyses will also be periodically conducted on drill cuttings. If soil cuttings are suspected to be hazardous (based on HNu™ measurements greater than 50 parts per million (ppm), odors, or discoloration), they will be placed in proper containers and characterized by toxicity characteristic leaching procedure (TCLP) for volatile organics and metals, as outlined in Section 2.1.6. Containerized hazardous waste will be removed from the field into an appropriate CSSA storage and handling facility and plans will be made for proper disposal. All removed drums will be labeled in accordance with the CSSA hazardous waste identification system.

1.1.6 Lithologic Descriptions

Lithologies will be described by a geologist using materials retrieved with a barrel sampler, cuttings during rotary drilling, or core samples. Lithology will be logged at 0.5-foot intervals and at each change of lithology.

Lithologic descriptions of unconsolidated material will consist of the predominant lithology in capital letters, followed by the predominant mineral content, secondary components and estimated percentage of sand, color, particle angularity, plasticity, significant structural or textural features, consistency (cohesive soil), density (non-cohesive soil), coherency, moisture content, and depositional environment and formation. Dimensions of the predominant and secondary particle sizes will be recorded using the metric system. Descriptions of clastic deposits will include symbols of the Unified Soil Classification System (ASTM D2487-85). Classification of color will follow Munsell color charts.

Lithologic descriptions of consolidated materials will follow standard professional nomenclature. Special attention will be given to describing fractures, vugs, solution cavities and their fillings or coatings, and any other characteristics affecting permeability. A sample drilling log form is in Appendix A. The vertical scale of the field logsheets will be appropriate for the level of detail noted.

To determine appropriate slot size and filter pack distribution for monitoring wells to be installed, a field sieve analysis will be performed during Stage II actions on soils from a site at which it is likely that a groundwater monitoring well may be required. Should groundwater be detected during drilling, the geologist shall ascertain from the soil or rock cuttings if the groundwater is most likely located within soils or rock formations. If the groundwater is within soils, and it is possible that a monitoring well might be required at the site in accordance with Section 3.1.1.2 of the Work Plan, then the geologist will use sieve analysis as described to perform a field check on the grain size distribution within

the soils. If the groundwater is found within limestone rock, then no sieve analysis is necessary.

The field sieve analysis will be performed in accordance with Groundwater and Wells (Driscoll, 1986). A portion of soil will be taken from the interval containing groundwater and allowed to air dry. The sample will be measured in a 100-mL graduated cylinder, then sieved by hand using 3-in sieves. Sieve sizes that should provide an adequate distribution for the clays and gravels expected at CSSA are US Standard Sieve Numbers 16 (0.047-inch sieve opening diameter for gravel or coarse sands), 40 (0.017-inch diameter for fine sands), and 100 (0.006-inch diameter for smaller particles). The volume of material retained on each sieve is measured via the cylinder. The volumes are divided by the total volume of the sample, and the resulting percentages plotted versus grain size on an arithmetic graph. To exclude the entrance of the majority of fine-grained soils into the wells, an appropriate filter pack size will be estimated at three to four times the 70-percent retained size of the sieved sample. The well screen slot size will be estimated to retain approximately 90 percent of the filter pack.

Because the sieve analysis is a field screening, the resulting estimation may indicate a filter pack size or well screen slot size that is not obtainable from typical well driller vendors, e.g., the filter pack or slot size would have to be a special order. Such orders are costly and are not necessarily warranted under field checks of sieve analysis. Therefore, should the above field analysis result in estimation of a filter pack size or screen slot size that is not obtainable through typical well driller vendors, the filter pack or screen slot size will be estimated at the closest size that is both appropriate for the soil type and cost-effective insofar as being obtainable from a vendor within a few days of the order.

The drilling log will also list the following information:

- Boring or well identification;
- Purpose of boring (soil sampling, monitoring well);
- Location in relation to a landmark;
- Name of drilling contractor;
- Description of drilling equipment including rod size, bit type, pump type, rig manufacturer, model number;
- Drilling method;
- Name of overseeing geologist;
- Types of drilling fluids, if any, and depths at which they were used;
- Diameter of boring;
- Depth at which saturated conditions were first encountered;
- Depths of lithologic boundaries, in feet or fractions thereof;
- Sample depths;

- Zones of caving or heaving;
- Depths at which drilling fluid was lost and amount lost;
- Volume of drilling fluid used;
- Changes in drilling fluid properties;
- Drilling rate; and
- Any problems encountered during drilling.

1.2 WELL CONSTRUCTION AND DEVELOPMENT

1.2.1 Monitoring Well Construction

The installation of necessary wells will begin within 1 week after determination, via chemical analysis of all soil samples, that the unsaturated-saturated interface in a boring contains contaminants. No breaks in the installation process will be made until the well has been grouted. In case of unscheduled delays such as personnel injury, equipment breakdowns, sudden inclement weather, well installation will continue as soon as possible.

All monitoring wells installed during this investigation will have an 8-inch diameter borehole. Except for those wells installed in soils instead of limestone as described in Section 1.1.6 and whose filter pack and screen slot are determined through sieve analysis, well construction materials, will consist of 2-inch schedule 40 PVC flush threaded casing with a minimum length of 5 feet of 0.020-inch factory-slotted screen. All PVC will conform to the ASTM standard F-480-88A or the National Sanitation Foundation standard 14 (plastic pipe system). All connections will be flush-jointed and threaded, and the well bottoms will be capped. Casing will extend from the top of the screen to approximately 2.5 feet above ground surface. All screens, casings and fittings will be new. No glues, solvents, or thread compounds will be employed during screen and casing installations.

Parsons ES will design the wells by the guideline outlined in the AFCEE IRP Handbook.

The well screen and casing will be centered and suspended about one foot off the bottom of the borehole as the annular space is being filled with sand pack. The pack will consist of washed and bagged well-rounded 20/70 mesh sand (predominantly siliceous). The pack size was selected to accommodate the slot size and the smallest anticipated particles that can practically be retained by pack and slots.

The filter pack will be placed from the bottom of the borehole to approximately 2 feet above the screen slot. The filter pack will be poured very slowly into the well annulus from the surface. If depth is greater than 15 feet, filter pack will be pumped. The volume of filter pack used must equal the calculated volume for the appropriate length of well annulus. If the pack materials have bridged, measures such as surging the well must be taken to enhance settling of the filter material. The top of the sand will not

extend to less than 4 feet bgl to allow adequate space for the seal and cement grout. The filter pack will be placed into the first water-bearing unit encountered in the borehole.

A 100 percent sodium bentonite seal will be placed above the sand pack to a minimum thickness of 2 feet to form an adequate seal above the pack materials. The bentonite seal will be hydrated in the hole with potable water (when the seal is above the water table) to ensure that the seal is developed before cementing operations begin.

Cement grout with bentonite gel will be placed from the top of the bentonite seal to 2 feet below ground surface. The grout will be mixed in the proportion described in Section 1.3. The grout will be placed in the annulus by the tremie pipe method, with the bottom of the tremie pipe set near the top of the bentonite seal.

1.2.1.1 Monitoring Well Completion Form

A well completion form, which is located in Appendix A will be completed for each monitoring well. The form will include the following information:

- Well location;
- Well identification;
- Installation date(s);
- Overseeing geologist;
- Elevation of ground surface and of the measuring point notch at the top of the casing;
- Diameter of surface casing, casing type, and methods of installation;
- Annular diameter of borehole for casing sets;
- Borehole diameter of production liner;
- Total boring depth;
- Lengths and descriptions of screen and casing;
- Lengths and descriptions of the filter pack, bentonite seal, casing grout, and any backfilled material;
- Volume of filter pack used,
- Volume of bentonite used for seal;
- Volume of grout used;
- Coupling/joint design and composition;
- Centralizer, if any, placement, design and composition;
- Drainage port location and size;
- Internal mortar collar location;

- Protective casing composition and nominal inside diameter;
- Any use of solvents, glues, and cleaners to include manufacturer and type;
- Steel post configuration; and
- Elevation of water level before and immediately after development.

1.2.1.2 Monitoring Well Surface Completions

Aboveground wells will be provided with a loose fitting telescopic cap to keep precipitation out of the casing. A 5-foot minimum length of new, black iron and steel pipe extending about 2.5 feet above ground surface will be set in the grout. The distance between the top of the well casing and the top of the protective casing will be no greater than 3.6 inches. The diameter of the protective casing will be 6 inches. An internal mortar collar will be placed within the well-protective casing annulus from ground surface to 0.5 foot above ground surface with a ¼-inch-diameter hole (drainage port) in the protective casing centered $^{1}/_{8}$-inch above this level. The mortar mix will be (by weight) 1 part cement to 2 parts sand (the filter pack), with minimal water for placement. This must be allowed to set at least 48 hours prior to well development. Pea gravel will be put inside the protective casing from the top of the mortar collar to below the top of the casing to ease tool retrieval and to prevent small animals from entering through the drain. Four 4-inch-diameter, 6-foot-long steel guard posts, which are filled with concrete, will be placed 2 feet radially around the protective casing outside of the concrete surface pad. They will be placed about 3 feet bgl and will rise a minimum of 3 feet above ground surface. The surface pad will slope away from the well, be approximately 8-inches thick, and extend 2 feet radially from the protective casing.

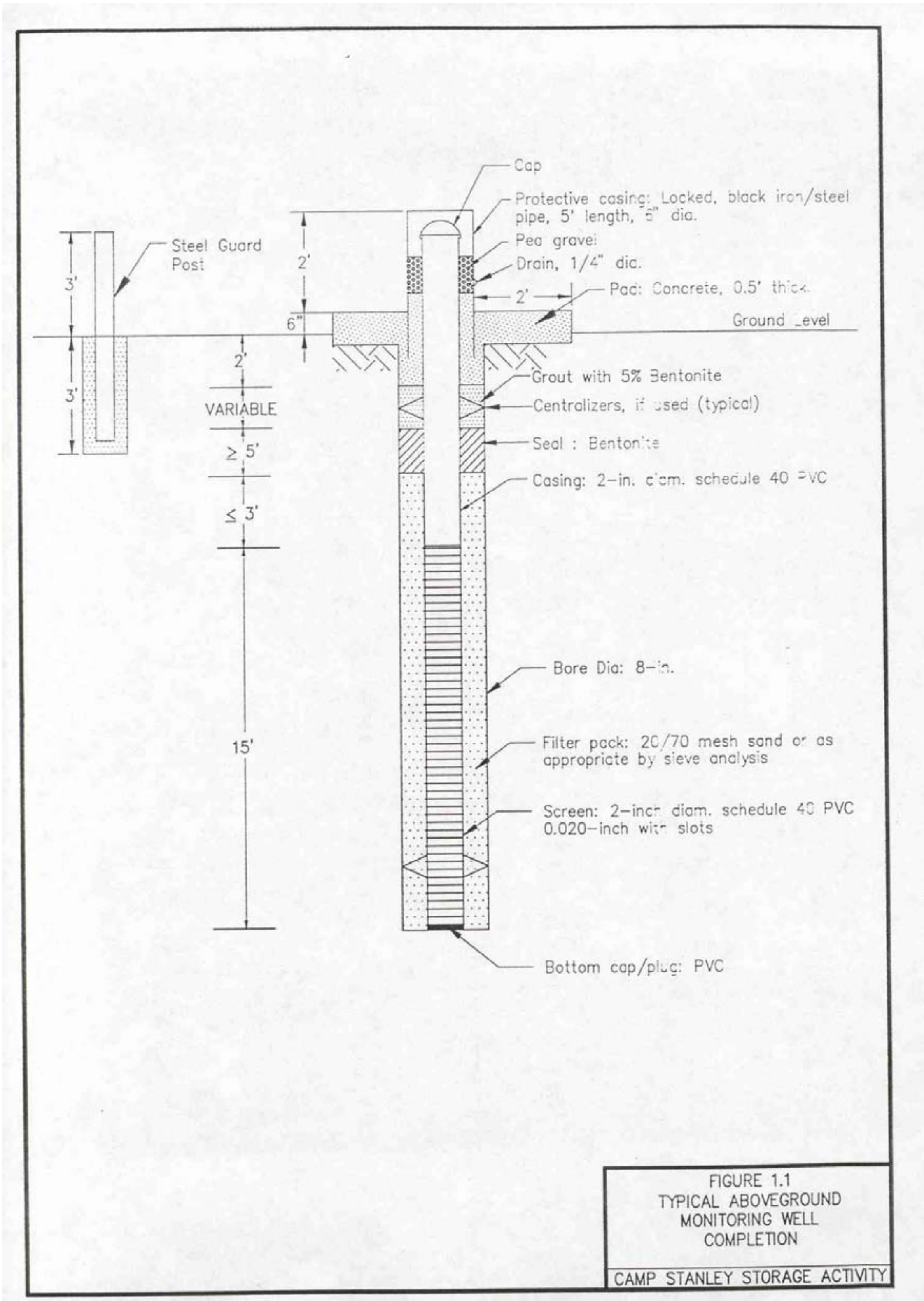
A rounded brass monument will be placed on each monitoring well concrete pad to serve as a permanent benchmark. All wells will be secured as soon as possible after drilling with corrosion-resistant locks. The locks will all be keyed all the same, and the keys will be provided to CSSA following completion of the field effort. Figure 1.1 illustrates typical aboveground monitoring well completions.

The identity of the well will be marked on the casing cap and the protective casing. In addition, a brass monument with the monitoring well number stamped in it will be placed into the concrete pad for identification purposes during the project. The protective casing and guard posts will be painted with a color specified by the post facility civil engineer. A monitoring well completion diagram is located in Appendix A.

1.2.2 Monitoring Well Development

Monitoring wells will be developed as soon as possible but no sooner than 48 hours after internal mortar collar placement has been completed. All fluids used during well construction will be removed during development. Development will be accomplished with a pump and will be supplemented with a bottom discharge and filling PVC bailer (for sediment removal) (EPA, 1992). A 5-ft stainless steel lead will be attached to the bailer. Clean nylon rope will be used to raise and lower the bailer and the stainless steel

Figure 1.1 Monitoring Well Completion Diagram (Aboveground)



lead. Before well development begins, the water level will be measured within 0.01 foot using a graduated water level indicator (e-line) with respect to a reference point permanently marked on the north side of the top of the casing. Any conditions which may affect water levels shall be recorded in the field log. The measurement device will not alter sample composition.

During development, water will be removed throughout the entire water column by periodically lowering and raising the pump intake. Well development will continue until the following conditions are met:

- A minimum removal of three well bore (or pore) volumes of water.
- The well water is clear to the unaided eye.
- The sediment thickness remaining within the well is less than 5 percent of the screen length.

The well bore (or pore) volume is defined as the volume of submerged casing, screen and filter pack (assuming a 30 percent porosity). If recharge rates are slow and the required volume cannot be removed in 48 consecutive hours or the water remains discolored or excess sediment remains, the AFCEE and CSSA points-of-contact will be contacted for guidance. A minimum of five additional pore volumes will be removed when excess sediment remains.

Specific conductance, pH, and temperature measurements will be taken once before, twice during, and once after development. These measurements will be recorded on the development logs. If pH and conductivity stabilize during the removal of the final two pore volumes, the well will be considered to be developed. The pH, conductivity, and turbidity meters will be calibrated daily. Calibration procedures are further described in Section 3.

Development water will be containerized pending laboratory analysis. Water deemed to be hazardous will be handled and disposed in accordance with all applicable laws and regulations as described in Section 1.7 of this FSP.

Well development data recorded on the well development logs include:

- Volume of water removed from the well;
- Measurements of pH, conductivity, and turbidity;
- Static water level from top of casing before and 24 consecutive hours after development has been completed;
- Volume of water in well and in saturated annulus prior to development;
- Type and size/capacity of pump and/or bailer used; and
- Description of surge techniques, if used.

Water removed from a well during development will not be counted towards any pre-sample purging requirements.

1.2.3 Monitoring Well Purging

Using the static water level, well casing diameter, and total depth of the well, one well casing volume is calculated and recorded. Purging is performed by removing 3 to 5 well casing volumes from each monitoring well. The water is removed via a decontaminated bailer or pump and placed in a drum with a locking lid pending laboratory analysis. If the water is determined to not be contaminated by laboratory analysis, it will be poured out onto the ground inside the SWMU. The bailer rope should not be allowed to touch the ground during sampling. For every 5 gallons removed, measurements of pH, temperature, and specific conductivity are collected and recorded on the groundwater purging and sampling form. The measurements of groundwater must be within ±0.5 pH units, ±1°C, and ±10% µmhos/cm per container. When at least three subsequent measurements are within 10% of each other, it is indicative that the water is removed from the aquifer rather than from the well casing. The water level is then allowed to recharge to at least 80% of the static water level or to recharge for at least 16 hours, whichever occurs first, before sampling. The well will be sampled within 24 hours of purging.

1.3 BOREHOLE ABANDONMENT PROCEDURES

Soil boreholes will be abandoned to prevent migration of substances between geological formations or from the surface. All soil borings will be plugged as soon as possible after completion of use in a period not to exceed 3 days. Abandonment information will be included on the drilling log form. A sample of this log is in Appendix A.

Once approved, the borehole to be abandoned will be sealed by grouting from the bottom of the boring to ground surface. Grout will be pumped into the borehole until undiluted grout flows from the boring at ground surface. The grout will be mixed in the following proportions: 94 pounds (one sack) neat Portland type I cement to 100 percent sodium bentonite powder with approximately 8 gallons of approved water. The bentonite will be added after the required amount of cement is mixed with water. A mud balance will be used to determine the grout weight. This weight will be recorded on the drilling log. The weight should be between 13.2 and 14 pounds per gallon. Grout will be thoroughly mixed and free of lumps before placement. After 24 hours, the abandoned site will be checked for grout settlement. Any settlement depression shall be filled with grout and rechecked 24 hours later. This process will be repeated until firm grout remains at ground surface without any depressions.

1.4 SURVEYING

The surveying procedures described in this section are general guidelines for mapping the investigated SWMU. These guidelines may be modified if additional

equipment, such as global positioning systems (GPS), are to be used. Field personnel will create a field map of the investigated SWMU through techniques described below.

1. Utilizing existing records or other known data, estimate the location and size of the SWMU.

2. Stake the estimated area and provide distance locations to known reference points (i.e., roads, buildings, etc.).

3. For providing a geophysical survey, stake the gridpoints as described in Section 1.1.2 of this FSP. Obtain concurrence of gridpoint location from CSSA and AFCEE.

4. After data reduction has been completed from the geophysical survey of the investigated SWMU, modify the map to reflect findings of the geophysical survey.

A map is currently available, or will be provided, for each investigated SWMU that specifically identifies the location of the SWMU.

1.5 EQUIPMENT DECONTAMINATION

To prevent sample contamination from the onsite sampling equipment and machinery, decontamination will be conducted using the following procedures.

A decontamination pad, large enough to fully contain the equipment to be cleaned, will be set up. One or more layers of heavy plastic sheeting will be used to cover the ground surface. Sampling equipment that will come into direct contact with samples will not be allowed to come in contact with the plastic.

Drill rigs, drill pipe, and other equipment that does not come into contact with the sample medium will be decontaminated with a steam cleaner before initial use and after each borehole is completed. Drill bits will be decontaminated with a steam cleaner prior to use at each boring or monitoring well location. If the hot water cleaning alone is found to be ineffective, the equipment may be scrubbed with laboratory-grade detergent, then rinsed with high-pressure steam. All visible dirt, grime, grease, oil, loose paint, etc., will be scrubbed until it has been removed. When possible, drilling will proceed from the "least" to the "most" contaminated sites.

The casing, centralizers, and screen will either be certified clean by the manufacturers or will be decontaminated by steam cleaning.

Purge and development equipment such as pumps will be decontaminated by flushing or pumping laboratory-grade detergent solution, potable water, then ASTM Type II Reagent water (Reagent Grade II water) through the internal components (in the order listed below). The exterior of the pump inlet hose will be steam cleaned.

Sampling equipment includes augers, continuous-core samplers, hand trowels, bailers, pH meters, conductivity meters, shovels, knives, spatulas, and compositing bowls that directly contact samples. The following steps must be followed when decontaminating this equipment:

1. Set up a decontamination area at the site. The decontamination area should progress from “dirty” to “clean” and end with an area for drying decontaminated equipment. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. However, sampling equipment to be used for organic sample collection shall not come in contact with plastic after the final rinse; oil-free aluminum foil must be used. Plastic sheeting must also be placed to capture Reagent-Grade II water, hexane, and methanol used for rinsing equipment.
2. Wash the item thoroughly with a soapy, laboratory-grade detergent solution. Do not submerge pH meters or conductivity meters. Use a stiff-bristle brush to dislodge any clinging dirt. Disassemble any items that might trap contaminants internally before washing. Do not reassemble until decontamination is complete, and the items are dry.
3. Rinse the item in clear potable water. Rinse water should be replaced as needed, generally when cloudy.
4. Using an appropriate manual pump sprayer, rinse the item with ASTM Type II Reagent water.
5. Rinse equipment with pesticide grade methanol.
6. Rinse equipment with pesticide grade hexane.
7. After drying, wrap the cleaned item in oil-free aluminum foil for storage at least two feet above the ground.
8. Record the decontamination protocol, equipment, and description together with the date and time of decontamination in the appropriate logbook.
9. After decontamination activities are completed, collect disposable gloves, boots, and clothing. Place contaminated items in proper containers for disposal.

Decontamination fluid will be containerized pending analytical analysis of samples from the site. Decontamination fluids that are suspected to be hazardous will be disposed of in accordance with all applicable laws and regulations. Hexane and methanol cannot be disposed of by pouring on the ground. These chemicals will be captured and will be disposed as investigation-derived waste as explained in Section 1.7. Parsons ES will assist CSSA in planning the disposal of waste materials and fluids which cannot be treated at the wastewater treatment plant (WWTP).

Environmental samples scheduled for collection are believed to contain no or minimal waste or waste residues; therefore, the steps previously identified will provide for sufficient decontamination of the sampling equipment.

To ensure that the sampling equipment has been successfully decontaminated, an equipment blank will be collected at the rate of one per twenty samples. The equipment blanks will be analyzed for the same parameters as the other field samples collected during the field event.

1.6 FIELD ACTIVITIES

Parsons ES will complete the following tasks in anticipation of obtaining the necessary documentation for closure of the specified solid waste management units:

- Letter reports to delist two low priority solid waste management units (B-14 and coal bins).

- Minimal field investigations for six low priority SWMUs (B-5, B-6, B-7, B-22, B-25, and B-26), including sampling and analysis.

- Conventional field investigations for thirteen medium priority SWMUs (B-1, B-8, B-9, B-12, B-13, B-19, B-27, B-29, B-30, B-31, B-32, B-33, and B-34), including topographical and geographical surveys and surface and subsurface soil sampling. In addition, groundwater will be sampled and analyzed if encountered during subsurface investigations.

- Mapping, geophysical surveys, and soil gas surveys at three high priority units (building 43, incinerator-1, and B-10).

- Soil gas surveys at three high priority SWMUs (B-15/16, B-23, and 23A).

- Additional closure activities will be performed for other high priority SWMUs should budget and schedule allow.

Two of the eight low priority sites do not require investigation, sites B-14 and the coal bins. The minimal field investigations for six of the eight low priority units (B-5, B-6, B-7, B-22, B-25, and B-26) will include mapping, geophysical surveys, and a minimum three surface soil samples. Geophysical surveys and a minimum of three soil borings will be completed at all thirteen medium priority sites. Samples will be taken from each soil boring, at the surface, middle, and total depths. If groundwater is encountered in a soil boring, the saturated/unsaturated interface of that boring will be sampled and analyzed for the contaminants discovered at the surface. If the interface is discovered to be contaminated, the boring will be completed as a groundwater monitoring well.

The additional high priority SWMUs will undergo noninvasive investigations to help identify closure potential.

The WP has a detailed description of all activities planned for the investigated SWMUs at CSSA.

1.7 INVESTIGATION-DERIVED WASTE HANDLING

Management of Investigation-Derived Wastes During Site Inspections (EPA, 1991) will be used as guidance for waste management methods during this project. This section describes the manner in which IDW will be handled at CSSA.

The onsite handling options provided by the EPA, when IDW are not Resource Conservation and Recovery Act (RCRA) hazardous as defined in 40 CFR 261.3, are listed below. These are only options and not necessarily the course of action that will be taken during the investigations at CSSA.

For soil cuttings:

- Spread around the well or boring,
- Put back into the boring, or
- Place into 55-gallon container.

For groundwater:

- Pour onto ground next to the well to allow infiltration, or
- Place into 55-gallon container.

For decontamination fluids:

- Pour onto ground (from containers) to allow infiltration, or
- Place into 55-gallon container.

For decontaminated personal protective equipment (PPE) and decontamination equipment (DE):

- Double bag and deposit in the site dumpster, or in any municipal landfill.

If IDW consists of RCRA hazardous soils that pose no immediate threat to human health and the environment, the EPA recommends leaving the soils onsite within a delineated SWMU. CSSA will provide direction for disposing of RCRA hazardous IDW materials.

A solid waste is a RCRA characteristic hazardous waste if it exhibits the characteristics of ignitability, corrosivity, reactivity, or toxicity defined in 40 CFR 261 Subpart C. Toxicity is determined in accordance with the toxicity characteristic leaching procedure (TCLP).

Wastes anticipated as a result of investigation actions are drill cuttings, PPE, DE, and decontamination water.

A small quantity of drums containing suspected hazardous waste may also be generated during drilling operations. Soil cuttings suspected to be hazardous based on site knowledge, field screening observations, odors and discoloration, and PID readings will be placed in clean 55-gallon U.S. Department of Transportation (DOT) approved drums.

Water generated during development or purging will be poured out onto the ground if there are no signs of contamination. If any water is suspected to be contaminated, through field screening observations, the water will be sampled for characterization prior to disposal.

For IDW suspected to be contaminated (i.e., those wastes that have been placed into appropriate containers), hazardous characterization will be conducted in accordance with applicable EPA and TNRCC regulations. Composite samples will be collected from drums of the same boring or SWMU location. Each sample will be from a maximum of ten drums. The composite samples will have TCLP analysis for RCRA hazardous waste constituents as provided by 40 CFR 261.

SECTION 2
ENVIRONMENTAL SAMPLING

2.1 SAMPLING PROCEDURES

Different types of samples will be collected throughout the project. The following sections describe the various procedures for discrete sample collection.

2.1.1 Surface Soil Samples

Surface soil is usually referred to as the soil extending from the surface to a depth of 2 feet. Surface-soil samples will be collected to characterize each SWMU as identified in the WP.

Surface soil is collected using stainless steel and/or Teflon™-lined scoops, trowels, shovels, spoons, or spatulas. The following steps must be followed when collecting the samples:

1. Carefully remove stones, vegetation, etc., if possible, from the sampling location surface.
2. On the surface, carefully remove the top 1 to 2 cm (around 4 to 8 mL) of exposed soil before sample collection. For deeper soil samples, remove overlying soil as necessary with a decontaminated auger, shovel, or similar device.
3. Obtain and record PID readings in the breathing zone and 1 to 2 inches from the exposed soil.
4. Use a clean, stainless steel or Teflon™-lined scoop, trowel, or shovel to collect sufficient material in one grab to fill the sample containers.
5. For volatile organic analyses (VOA) and semivolatile organic analyses (SVOA) samples, fill the containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Leave minimal headspace in the container.
6. Label container with the appropriate information. Place in Ziploc® or other plastic bag and seal the bag. Maintain proper chain-of-custody documentation. Chain-of-custody procedures are detailed in Section 5.2 of the QAPP.
7. Pack sample in cooler with ice.
8. Use decontaminated sampling equipment at each sample location to prevent cross-contamination.

One trip blank will be included in each ice chest that contains soil and/or water samples which are to be analyzed for VOCs. Trip blanks will be supplied by the laboratory and will only be analyzed for VOCs.

Soil samples will be analyzed for VOCs, SVOCs, total metals, and explosives. Sample containers, analytical methods, preservation, and holding times for soil samples are listed on Table 2.1. One field sample duplicate will be collected for every ten soil samples collected. Field duplicates are further described below.

Soil samples for chemical analyses will be marked to identify boring and depth, and cooled on ice to 4°C ±2°C for preservation. The sample jars will also be marked with analyses to be performed, date and time of collection, and initials of samplers.

2.1.2 Collection of Duplicate Samples.

Duplicate samples are typically obtained for either of two purposes: (1) as a means of assessing quality control from the point of sample collection through all analytical processes (if the initial and duplicate samples are not within specification, the reasons for the discrepancy must be found and corrected, if possible), or (2) for later laboratory analyses, if needed. For this project, duplicate samples will be collected to provide information on the variability of the contaminants in the field.

The following steps must be followed when collecting duplicate samples:

1. Determine the frequency of obtaining duplicate samples as specified in the site-specific sampling plan (one duplicate for every ten soil or groundwater sample).
2. Proceed with site sampling to the point that a duplicate sample is required.
3. Collect the duplicate sample by dividing one grab sample into two equal parts. Note: Any sample or portion of a sample that is to be analyzed for VOCs and SVOCs shall be collected and contained immediately. Do not stir, mix, or agitate samples scheduled for VOC and SVOC analysis before containment.
4. Follow the specific media sampling procedures outlined in Section 2.1.1. The preparation and disposition of the duplicates will be the same as those for the primary samples.
5. Obtain VOC and SVOC samples first (without mixing or compositing), then proceed to Step 6. Mix all non-VOC/SVOC replicate samples as previously detailed. Mixing water may be accomplished by pouring a portion of the sample directly from the sampling device into the original container, and then pouring an equal portion into the duplicate container, alternating between the two until the sample containers are full. In the case of sampling for nonvolatiles in soils and sediments, the mixture may be homogenized by placing the entire sample into a stainless steel or Teflon™-lined mixing bowl and mixing the sample thoroughly before collecting the duplicates using the methods described in Section 2.1.1.

Table 2.1 Sample Container, Methods, Preservation, and Holding Times for Soil Samples

Parameters	Analytical Method	Sample Container	Preservation	Holding Times
Volatile Organic Compounds	SW8260A	One 4-ounce widemouth glass jar with Teflon-lined lid	Cool to 4°C ±2°C	14 days
Semi-Volatile Organic Compounds	SW8270B	One 8-ounce widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	Extract within 14 days of collection and analyze within 40 days of extraction
Explosives	SW8330 (lab modified)	One 8-ounce widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	Extract within 14 days of collection and analyze within 40 days of extraction
ICP Metals (Barium, Chromium, Zinc, Nickel, Copper)	SW6010A	One 8-ounce widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	180 days
Arsenic/ Cadmium/ Lead	SW7060A/7131/7421	One 8-ounce widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	180 days
Mercury	SW7471A	One 8-ounce widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	28 days for glass; 13 days for plastic

6. Place the sample(s) in the appropriate sample container. Duplicate samples will be labeled blind or tagged according to their intended use. Duplicate samples must be properly identified in the field logbook.
7. Seal, pack, and transport duplicate samples in the same manner as that used for other samples from the sampling site.

2.1.3 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample Collection

Matrix spike (MS) and matrix spike duplicate (MSD) samples from a specific media are spiked with known quantities of analytes at the laboratory. The analytes used as spiking compounds will depend upon the analytical method used.

MS and MSD samples are a form of laboratory quality assurance/quality control (QA/QC) for determining matrix effects and the reliability of the analytical processes and equipment. The matrix effect is a condition in which sample composition interferes with the analysis of the desired analyte(s). Spiked sample recovery supplies percentage recovery information so that the laboratory can evaluate its measurement accuracy. MS and MSD samples are equal portions of a single initial sample that has been spiked in the laboratory with specific analytes in known quantities and the analytical results must meet certain laboratory requirements to be acceptable.

One MS and one MSD sample shall be collected and analyzed for every twenty project samples collected.

The following steps must be followed when preparing MS/MSD samples:

1. Determine the frequency of obtaining MS and MSD samples as stated in the site-specific sampling plan (one for every twenty samples).
2. Proceed with site sampling to the point of obtaining the MS and MSD samples. Any sample or portion of a sample that is to be analyzed for VOCs and SVOCs shall be collected and contained immediately. Do not stir, mix, or agitate samples scheduled for VOC and SVOC analysis before containment. For groundwater, triplicate volume is typically required, so fill MS/MSD containers after collecting the sample at a particular location.
3. Follow the specific media sampling procedures outlined in Section 2.1.1. The preparation and disposition of the MS/MSD samples will be the same as those for the primary samples.
4. Seal the containers as soon as filled. Clean the outside of the sample containers and label the three containers.

Field personnel will ensure that each container is identified with a self-adhesive label to indicate the project name, sampling location, time, date, sampler initials, preservative(s) added, if any, and analysis required.

Each sample will be identified with a separate identification label. Example sample identification label and seal are presented in Section 2.2. The label will document:

- Analyses to be performed,
- Sample identification number,
- Source/location of sample,
- Date,
- Time (a four-digit number indicating the 24-hour clock time of collection; for example 1430 for 2:30 p.m.), and
- Sampler's initials.

2.1.4 Subsurface Soil/Rock Sampling

Rock samples will be collected for chemical analysis using a air rotary drill rig and a core barrel. When the top of the sampling interval is encountered, air will be circulated in the hole to remove as many cuttings as possible. Then, the string of drill pipe will be removed from the hole. The core barrel will then be attached to the drill string and run into the hole. Coring will be performed very slowly to minimize heating of the rock and core barrel. After the core has been brought to the surface and removed from the core barrel, rock selected for chemical analysis will be broken off from the core with a hammer and placed in the appropriate sample jar.

The depth intervals of these samples will be chosen based on changes in lithology and field screening observations. These samples will be analyzed for VOC, SVOC, metals, and explosives. Special care will be taken in all sampling, handling, packaging, and shipping of all samples. Sample container, analytical methods, preservation, and holding times are listed on Table 2.2. The sample will be labeled with the project number, project name, date of sampling, core number, interval of sampling, and any other pertinent information.

2.1.5 Groundwater Sampling

Groundwater samples will be collected from each monitoring well for chemical analysis. The purging and sampling procedures will be documented in the field book and on development/purging forms located in Appendix A.

Necessary equipment to measure water levels and collect samples includes:

- Electric water level measurement tape;
- Teflon™ bailer or portable pump;
- Nylon rope (with stainless steel lead);
- Plastic sheet;
- Water collection bucket and/or drum;
- Field-grade pH, temperature, and specific conductivity meter;

- PID if necessary for health and safety monitoring;
- Decontamination equipment (potable water, nonphosphate soap, and brushes);
- PPE;
- Sample jars from laboratory; and
- Sample labels, chain-of-custody records, and groundwater sampling forms.

Before sampling begins, sample containers will be prepared with appropriate labels and preservations. Groundwater sample containers, analytical methods, preservation, and holding times are shown in Table 2.2.

The initial well purging and sampling will take place at least 24 hours after well development is completed. Before each monitoring well is purged and sampled, the water level will be measured within ±0.01 foot with respect to the reference point on the top of the casing. The air in the breathing zone will be checked with a PID every time a casing cap is removed and recorded in the field log book along with other pertinent data, such as time and date.

After the water level is recorded, the well will be purged to remove any stagnant water. Either a PVC bailer or a submersible pump will be used to purge the well. All purging and sampling equipment will be decontaminated prior to use following the procedures described in Section 1.5. Purging and sampling will be performed in a manner that minimizes the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into the well.

At least three well casing volumes of groundwater will be removed from each monitoring well prior to sampling. A casing volume differs from a pore volume in that it includes the volume of water within the well casing only. A pore volume includes the casing volume and the volume of water within the filter pack. Based on previous monitoring well sampling at CSSA leaking tank sites, it is not expected that perched water will provide even three well casing volumes. The temperature, pH, and conductivity will be measured and recorded after each 5-gallon volume is removed during purging. The sample may be collected after three casing volumes have been removed and the temperature, pH, conductivity, color, and odor have stabilized. These parameters will be considered stable when pH varies ±0.1 unit, temperature varies ±0.5 ^{o}C, and conductivity varies ±10 μmhos/cm or less during the removal of at least three well volumes. If these parameters do not stabilize, the sample will be taken after five casing volumes have been removed. Calibration of the pH, temperature, and conductivity meters is discussed in Section 3.4. Disposal of water generated during purging is described in Section 1.7.

Table 2.2 Sample Container, Methods, Preservation, and Holding Times for Aqueous Samples

Parameters	Analytical Method	Sample Container	Preservation	Holding Times
Volatile Organic Compounds	SW8260A	Three 40-mL glass vials with Teflon-lined septum	HCI to pH<2; Cool to 4°C ±2°C	14 days
Semi-Volatile Organic Compounds	SW8270B	One 1-liter widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C	Extract within 7 days of collection and analyze within 40 days of extraction
Explosives	SW8330 (lab modified)	One 1-liter widemouth amber glass jar with Teflon-lined lid	Cool to 4°C ±2°C Store in the dark	Extract within 7 days of collection and analyze within 40 days of extraction
ICP Metals (Barium, Chromium, Zinc, Nickel, Copper)	SW6010A	One 500 mL plastic bottle	HNO_3 to pH<2; Cool to 4°C ±2°C	180 days
Arsenic/ Cadmium/ Lead	SW7060A/7131/7421	One 500 mL plastic bottle	HNO_3 to pH<2; Cool to 4°C ±2°C	180 days
Mercury	SW7470A	One 500 mL plastic bottle	HNO_3 to pH<2; Cool to 4°C ±2°C	13 days

HNO_3 = nitic acid

Samples will be collected after the water level has recovered to 80 percent of its static level, or 16 hours after completion of purging, whichever occurs first. When a low-yield monitoring well is pumped or bailed dry before three well pore volumes have been removed, the sample will be collected as soon as the volume of recovered fluid is sufficient for sampling.

Groundwater samples will be collected in order of increasing anticipated contamination when possible, using a PVC bailer with stainless steel leader (EPA, 1992). Careful use of the bailer will minimize sample agitation and contact with air. A clean length of nylon cord will be used for raising and lowering the bailer and stainless steel leader in each well.

The sampling form will record the following:

- Site identification and well number;
- Time and date;
- Sounded total depth of the monitoring well, depth to water before and after purging, actual volume of water purged, thickness of any floating hydrocarbon layer, depth to water before and after sampling;
- Field measurements of pH, temperature, and conductivity, and equipment calibration information; and
- Appearance and odor of the purged water, the condition of the well, weather conditions, and other comments.

Required preservatives will be added to the sample bottles before sample collection. The pH of preserved samples will be checked in the field by pouring a small amount of sample onto pH paper. The range of the pH paper will closely bracket the expected pH. The paper must not touch the sample inside the container. The pH of acidified VOC samples will not be checked.

Samples to be analyzed for VOCs will be collected first and immediately sealed in a container so that no headspace exists. Samples for volatile organic analyses will not be composited, homogenized, or filtered.

2.1.6 IDW Sampling

IDW will be sampled to characterize the waste(s) for disposal. Drill cuttings suspected to be hazardous from HNu™ or OVA readings, odor, or discoloration will be placed in clean 55-gallon U.S. DOT drums as described in Section 1.7. Composite samples will be collected from these drums and analyzed for TCLP organics and metals identified in the analysis of the discrete samples collected during field activities. The extraction method for TCLP is SW-1311. All RCRA nonhazardous IDW will be placed on the ground. No QA/QC samples will be associated with waste characterization sampling.

2.1.7 Leachate Sampling

Leachate samples will be collected from each monitoring lysimeter for chemical analysis. The sampling procedures will be documented in the field book.

Necessary equipment to collect samples includes:

- Teflon™ bailer or portable pump;
- 0.45 micron filters and/or 0.1 micron filters;
- Nylon rope (with stainless steel lead);
- Plastic sheet;
- Water collection bottle;
- Decontamination equipment (potable water, nonphosphate soap, and brushes);
- PPE;
- Sample jars from laboratory; and
- Sample labels, and chain-of-custody records.

Before sampling begins, sample containers will be prepared with appropriate labels and preservations. Leachate sample containers, analytical methods, preservation, and holding times are shown in Table 2.2.

The initial leachate sampling will take place within 24 hours after rainfall event. Either a PVC bailer or a peristaltic pump will be used to sample the lysimeter. All sampling equipment will be decontaminated prior to use following the procedures described in Section 1.5. Sampling will be performed in a manner that minimizes the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into the lysimeter.

Leachate samples will be collected and filtered with a 0.45 micron filter before placing into sample container with the appropriate preservative, as described in Table 2.2, or into a one-liter amber jar for further filtering. Use of a 0.1 micron filter requires a syringe with filter attachment and is accomplished on the portion of leachate remaining in the one-liter amber jar. The filtered leachate is then placed into a separate sample container with preservatives as noted in Table 2.2.

Required preservatives will be added to the sample bottles before sample collection. The pH of preserved samples will be checked in the field by pouring a small amount of sample onto pH paper. The range of the pH paper will closely bracket the expected pH. The paper must not touch the sample inside the container.

Samples to be analyzed for VOCs will be collected first and immediately sealed in a container so that no headspace exists. Samples for volatile organic analyses will not be composited, homogenized, or filtered.

2.2 SAMPLING HANDLING

All samples will be placed in precleaned (to EPA level 3) glass and plastic bottles for shipment to the laboratory. All bottles will have Teflon™-lined lids. The precleaned bottles will be obtained from the subcontracted analytical laboratory or other suitable vendor.

2.2.1 Sample Identification

A sample numbering system will be used to identify each sample collected during the field investigation and for all samples. The numbering system will be a tracking mechanism to allow retrieval of information about a particular location and to ensure that each sample is uniquely numbered. A listing of sample numbers will be maintained by the field team leader. Each sample will assume the format described below.

There will be an alphanumeric identification code unique to each sampling location. Equipment rinsate and trip blanks will also be identified using an alphanumeric identification code. The field team leader will note in the field logbook which volatile samples are associated with each trip blank during shipment to the laboratory. Each sample number will consist of a location identification code and a consecutive sample number. Samples collected from soil borings will have the depth at which the sample is collected in parentheses following the sample number. The numbering system for duplicate samples will begin with the number 100.

The first two characters of the sample identification number will be one of the following:

- SB = Soil boring sampling location
- SS = Surface soil sampling location
- SW = Surface water sampling location
- GW = Groundwater sample
- EB = Equipment rinsate blank
- TB = Trip blank.

For example, SB5(20) is the soil sample collected at boring number 5 at a depth of 20 feet bgl.

Each sample will be labeled with a gummed tag (Figure 2.1) which is marked with:

- Sample identification,
- Time of collection (24-hour, four-digit),
- Date of collection (day, month, and year in the form dd-mm-yy),
- Sampler's initials,

- Analytical method name and number,
- Any field preparation of the sample (e.g., filtered), and
- Preservation method.

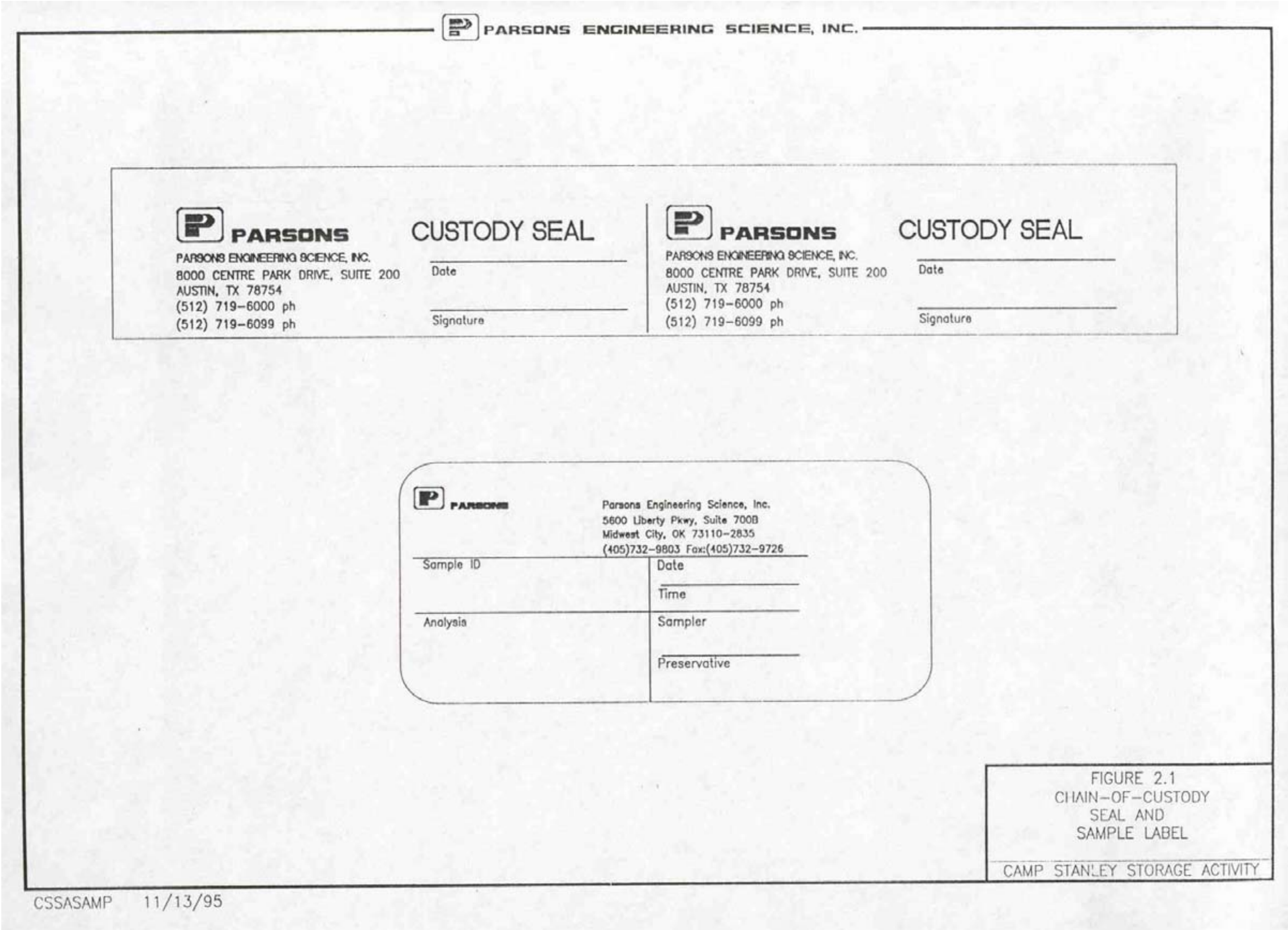
U.S. DOT shipping requirements will be followed when applicable.

The samples will be shipped in ice chests by an overnight carrier such as Federal Express. Glass bottles will be wrapped with polynet and bubble wrap and placed in an airtight plastic bag. A chain-of-custody (COC) form will be sealed in a plastic bag and taped to the inside lid of each ice chest. Each chest will be sealed with tape and a custody seal (Figure 2.1).

Prior arrangements must be made with the laboratory when collecting samples for these analyses. Overnight delivery may not be appropriate due to time constraints. In those cases, the samples may be hand delivered or shipped by other means. Field QA/QC of sampled materials will include the following:

1. Check all labels for legibility and accuracy; replace label if necessary.
2. Ensure that all labels are covered with wide, clear cellophane tape to protect labels during shipping.
3. Visually check the outside surface of the containers for proper decontamination. If any containers appear soiled, decontaminate again.
4. Check all container lids and tighten if necessary.
5. Wrap sample containers with foam packaging materials or bubble wrap to prevent breakage during shipping.
6. Place packed sample containers in individual zip-lock type plastic bags.
7. Place sufficient packaging material in the bottom and around the sides of the shipping cooler.
8. Place wrapped samples in the cooler. Complete and check chain-of-custody forms during packaging.
9. Add ice to the cooler in quantities adequate to maintain temperatures at 4°C ±2°C during shipment. Ice should be placed in zip-lock type plastic bags or blue ice should be used.
10. Fill excess space in cooler with packaging material to prevent movement of the sample containers. Styrofoam beads, peanuts, bubble pack, or other packaging material may be used.
11. The field team leader or a designee shall review the chain-of-custody paperwork and the sample packaging before releasing the cooler for delivery to the laboratory.

Figure 2.1 Example of Chain-of-Custody Seal and Sample Label



The paperwork which accompanies the samples to the laboratory is placed inside a zip-lock type plastic bag, sealed and taped to the inside of the cooler lid.

12. The following markings are placed on the top of the cooler:
    - Total quantity of coolers in shipment (i.e., 2 of 4);
    - Shipper's name and address.
13. The cooler is closed and sealed with packing tape in manner to prevent inadvertent opening during shipping.
14. A custody seal will be placed on the cooler in an area that would indicate if tampering had occurred.
15. A completed label for shipping by express carrier is attached to the top of the cooler, if necessary.

Call express carrier to arrange pick up of the coolers, or deliver to the most convenient carrier's office, or deliver to the laboratory.

2.3 SAMPLE CUSTODY

COC records provide a means of tracing each sample from the time of collection through shipment and final analyses, producing a written record of all persons handling the samples. A sample is defined as being under one's custody if it is in one's possession or in view after being in one's possession, or if that person placed the sample in a designated secure area.

The COC form will list sample identification, matrix, date and time of collection, preservatives used, analyses requested, name of sample collector(s), and the signature of each person receiving and relinquishing the samples. An example COC form is shown in Figure 2.2. The “Remarks” column of the COC form will be used to record additional information which may be of use to the laboratory for prescreening the samples, and to note any sample preservation methods used.

A COC record will accompany the samples at all times. When transferring possession of samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the record. This record documents transfer of sample custody from the sampler through any intermediary custodians to the laboratory.

Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis with a separate signed COC record included in each sample box or cooler. Shipping containers will be custody-sealed for shipment to the laboratory by overnight express delivery or courier service. Bills of lading will be retained as part of the permanent documentation in the project file. The original COC will accompany the shipment, and a copy will be retained by the field team leader. The laboratory will make and maintain a file copy, and the completed original will be returned as a part of the final analytical report.

Figure 2.2 Chain-of-Custody Form

PARSONS ENGINEERING SCIENCE, INC.

CHAIN OF CUSTODY RECORD

PARSONS ENGINEERING SCIENCE, INC.
8000 CENTRE PARK DRIVE SUITE 200
AUSTIN, TEXAS 78754
(512) 719-6000

PROJECT NAME/LOCATION	CARRIER ☐ Federal Express ☐ UPS Other
PROJECT NUMBER	AIRBILL OR CARRIER ID #
SAMPLER(S) (Signature)	

Date	Time	Sample ID/Desc.	Sample Type	Matrix	Sampling Method	Begin Depth	End Depth	NUMBER OF CONTAINERS	PRESERVATIVE	ANALYSIS REQUIRED	Ambient Condition Blank	Equipment Blank	Trip Blank	Cooler Letter	FIELD LOT CONTROL NUMBER	REMARKS

Relinquished by (Signature) Date Time	Relinquished by (Signature) Date Time	Relinquished by (Signature) Date Time
Received by (Signature) Date Time	Received by (Signature) Date Time	Received by (Signature) Date Time

White: laboratory returns with data; Yellow: laboratory copy, Pink: sampler copy.

Chain.cdr

FIGURE 2.2
CHAIN-OF-CUSTODY RECORD

CAMP STANLEY STORAGE ACTIVITY

CSSASAMP 11/13/95

2.4 QUALITY CONTROL SAMPLES

Four types of field QC samples will be collected during the entire investigative effort. Water used for blanks will have analytical data or a manufacturer's certification that verifies the quality of the water and shows it to be free of analytes and contaminants that may interfere with the required laboratory analyses. The water's electrical conductivity will be less than 1.0 µmhos/cm (at 25°C). Type II reagent-grade water will be purchased and stored only in glass or Teflon™ containers with Teflon™ caps or cap liners.

2.4.1 Trip Blanks

One trip blank will accompany every cooler shipped to the laboratory which contains soil and/or water samples to be analyzed for VOCs. A trip blank is a VOC sample bottle filled in the laboratory with type II reagent-grade water, transported to the site, handled like a sample, and returned to the laboratory for analysis. If there is more than one sampling team, only one team will carry a trip blank to the sampling locations. Trip blanks will not be opened in the field. This blank will be analyzed for VOCs only. The sample ID for trip blanks will be FIELDQC. The sample type will be TB numbered sequentially starting with 1 (e.g.TB1).

2.4.2 Equipment Blanks

One equipment blank will be collected for every twenty soil or groundwater samples taken. An equipment blank is type II reagent-grade water that is poured onto the sampling device, transferred to a sample bottle, and transported to the laboratory for analysis. This blank will be subjected to all laboratory analyses requested for environmental samples at the site at which the blank is collected. The sample ID will be FIELDQC. The sample type will be EB, numbered sequentially starting with 1 (e.g., EB1).

2.4.3 Field Duplicate Samples

One field duplicate will be taken for every ten environmental samples collected. A field duplicate is one of two samples collected independently at a sampling location during a single act of sampling. Both the sample and its duplicate will be analyzed for the same constituents in the laboratory.

2.4.4 MS and MSD Samples

One set of MS/MSD samples will be collected for every twenty soil, water, and sediment samples taken. MS and MSD samples each require the same sample volume that the environmental sample requires. The sample type is MS for the matrix spike, and SD for the matrix spike duplicate and numbered sequentially starting with 1 (e.g., MS1 and SD1).

2.4.5 Standard Reporting Units

The following standard reporting units will be used during phases of the project:

- PID readings will be reported to 0.2 parts per million (ppm),
- Temperature will be reported to the nearest 0.5°C,
- pH readings will be reported to the nearest 0.1 standard unit,
- Conductivity readings will be reported to the nearest 0.1 µmhos/cm,
- Water level measured in wells will be reported to the nearest 0.01 foot, and
- Soil sampling depths will be reported to the nearest 0.1 foot.

2.5 SAMPLE ANALYSIS SUMMARY

A summary of the project analyses is shown on Table 2.3.

2.6 SOIL STOCKPILE SAMPLING PROCEDURES

Composite sampling is the required method for collecting a representative sample of stockpiled soil. A composite sample mixes similar material from different areas within a population to represent the entire population. Three levels of composite sampling are required to generate a representative sample. The first level of sampling is conducted in the field and is described in this section. A 5-gallon sample is collected during the first level of sampling. The second and third levels are collected in the laboratory and consist of a 1.25 gallon sample and a 100 gram sample, resepectively.

To conduct the first level of composite sampling the stockpiled soil should be in one of the two following configurations:

- A single flattened pile in the shape of a square or rectangle, no more than 3 feet deep. There are no restrictions on the length or width of the pile.

OR

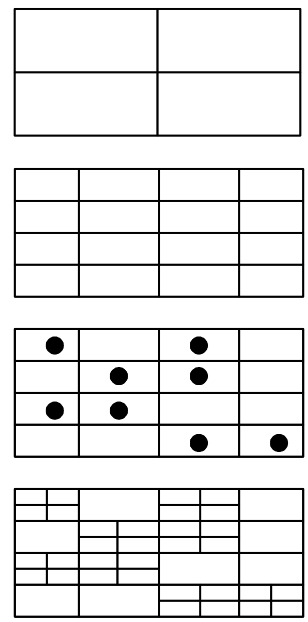
- A conical-shaped pile.

If the pile(s) to be sampled is not in one of these shapes, contemporaneous sampling should be conducted.

SAMPLING OF A SINGLE FLAT PILE

The strategy for sampling a single flat pile is to continually divide the pile into smaller and smaller subdivisions until the subdivisions have a volume of between 5 and 20 gallons. Then eight of these subdivisions are randomly selected for sampling. Specific steps are described below:

1. To sample a single flat pile of soil, the pile is first divided into quarters.
2. Each quarter is then divided into quarters, for a total of 16 areas.
3. The next step is to randomly select eight areas, two from each quarter.
   a) This can either be done by randomly selecting two areas in one quarter, then repeating those areas in the remaining quarters. OR
   b) Randomly selecting two areas in each quarter.

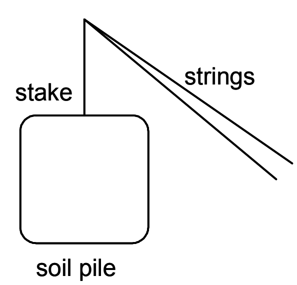


4. Next, the eight selected areas undergo further division and sample selection. Each of the eight selected areas are divided into four equal parts.
5. Using a random number generator, one of each of the four equal parts are selected.
6. If each of the selected areas has a volume of greater then 20 gallons, each selected area is continually divided into four parts and one part in each area is randomly selected until the volume of the selected part is less than 20 gallons, but more than 5 gallons. A total of eight selected parts, each with a volume of between 5 and 20 gallons, should result.
7. After the eight areas to sample have been selected, one sample of soil is collected from each.

SAMPLING OF A CONICAL-SHAPED PILE

Conical-shaped piles of soil are practical at sites where there is too much soil to spread out in the space available. These piles have a circular base, and soil is pile uniformly to a peak that is centered above the center of the circular base.

As with the sampling of a single flat-pile, a total of eight samples may be collected. The eight sample locations are randomly selected based on the depth (**t**), distance from the top of the pile (**s**), and the radial distance (**r**) a reference point. If there are multiple piles, a total of eight samples from all the piles (not eight from each) may be collected.



1. The first step is to set up a system for measuring various locations within each pile. A rod or stake with two pieces of string fastened to the top is positioned at the top of the pile. Each string should be long enough to stretch from the top of the pile to the outer edge. The strings attached to the stake should move freely around the pile, but should be as close to the pile as possible.

2. Next the radial component (**r**) of the location of a sample is determined.

   a) One of the two strings is fastened at the bottom of the pile **b** as a reference point for finding **r**.

   b) Then, the circumference (**c**), the distance around the bottom of the pile, is measured.

   c) Using a random number generator, a number between 1 and **c** is randomly selected.

   d) The radial component r is then located in the pile by traveling clockwise from point "**b**" the distance that was randomly selected above.

3. Next, the distance (**s**) from the center of the pile is determined for a sample.

   a) The length **1** of the string at **r** from the top of the pile to the bottom of the pile is measured.

   b) Using a random number generator, a number between 1 and the total length **1** is generated.

   c) Measure this random location **s** from the bottom of the pile and mark its location on the string **r**.

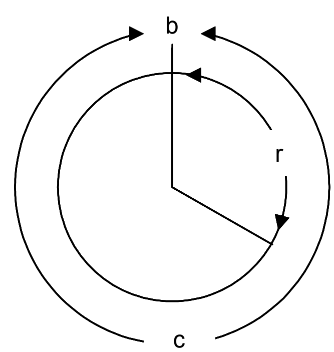
   d) Next, the distance (**s**) from the center of the pile is determined for a sample.

4. Finally, the depth **t** of a sample is determined.

   a) On another stake, mark and number 1 inch or 1 cm intervals. The stake must be long enough and strong enough to be forced down through the maximum depth of the pile.

   b) At position **s** along **r** determined as described above, push the stake into the soil until it reaches the ground. The total depth at **s** is **v**, the vertical distance.

   c) Using a random number generator, a number between 1 and the vertical distance **v** is generated.



Top View of Stockpile

5. Next, a hole is dug straight down into the pile a depth **t**, at the point **s** along **r**.

6. A depth **t**, on the top of the sample container is outlined in the soil. All soil under the outline should be shoveled into the sample container until the container is full.

7. Steps 2 through 6 are repeated until all samples have been collected.

Table 2.3 Summary of Project Analyses

Analysis	Matrix	Method Number
Metals		
Arsenic	Water/Soil	SW7060A
Barium	Water/Soil	SW6010A
Cadmium	Water/Soil	SW7131
Chromium	Water/Soil	SW6010A
Copper	Water/Soil	SW6010A
Lead	Water/Soil	SW7421
Mercury	Water	SW7470A
	Soil	SW7471A
Nickel	Water/Soil	SW6010A
Zinc	Water/Soil	SW6010A
Volatile Organics	Water/Soil	SW8260A
Semivolatile Organics	Water/Soil	SW8270B
Explosives	Water/Soil	SW8330 (lab modified)

SECTION 3
FIELD MEASUREMENTS

The following sections describe the equipment used in the field to measure specified parameters, procedures for equipment calibration, maintenance and decontamination.

Field measurements may be made using the following monitoring equipment:

- HNu™ PID,
- Organic vapor analyzer (OVA),
- Sensidyne™ one-stroke pump and colorimetric tubes,
- HMX 271™ combustible gas indicator,
- Hydac™ conductivity/temperature/pH meter,
- Hach™ Turbidimeter,
- Electric water level indicator,
- Hermit™ transducer and data logger,
- Leupold and Stevens™ Model 420 Recorder,
- Portable flume, weir or volumetric container, and stop watch, and/or
- Current meter.

3.1 HNU™ PHOTOIONIZATION DETECTOR AND ORGANIC VAPOR ANALYZER

Monitoring for total organic vapors and gases in the field will be conducted using the HNu™ PID or an OVA. The HNu™ measures up to 2,000 ppm organic vapors in the air while the OVA measures up to 10,000 ppm. Both will be used for various field screening techniques.

During surface soil sampling or drilling of soil and/or monitoring well borings, the PID will be used periodically to monitor the breathing zone, drill cuttings, borehole and undisturbed core samples. Headspace analyses of soil samples retrieved with a core sampler during drilling will also be tested with the HNu™ or OVA. All readings made with the HNu™ or OVA will be recorded either in the field logbook or directly on the field boring logs.

During well development, groundwater sampling, and surface soil sampling, the HNu™ or OVA will be used to monitor the breathing zone, and readings will be recorded

in the field logbook. Furthermore, immediately after the monitoring well cap is removed, a reading will be taken inside the top of casing. The frequency of air monitoring for these activities is defined in the project HASP (Parsons ES, 1995). Prior to use of the HNu™ or OVA for air monitoring, personnel will be thoroughly familiar with site-specific action levels defined in the HASP.

The HNu™ PID or OVA will be calibrated according to the user's manual at least once a day, prior to use in the field. The standard calibration gas for the HNu™ is isobutylene, which may be obtained in canisters from an environmental sampling equipment supplier. Methane is used as the calibration gas for the OVA.

3.2 SENSIDYNE™ ONE-STROKE PUMP AND TUBES

If the concentration of organic vapors in the breathing zone exceeds 1 ppm above background, benzene and vinyl chloride Sensidyne™ tubes will be used to determine whether these compounds are present. These two compounds have the lowest permissible exposure limit (PEL) of all suspected contaminants on site. Sensidyne™ tubes are compound specific and may be used to determine if the compound is present and to quantify the concentration. If needed, Sensidyne™ tubes will be used during drilling activities, monitoring well installations, subsurface soil sampling, groundwater sampling, and the geophysical surveys. The frequency of ambient air monitoring is detailed in the HASP.

The tube is physically broken open at one end, and ambient air is manually drawn through the system to obtain a direct reading. Sensidyne™ tubes do not require calibration.

Each Sensidyne™ tube contains a reagent system designed to undergo a chemical reaction with a particular substance. Since chemicals and chemical reagents are not stable indefinitely, each box of detector tubes is stamped with an expiration date. The tubes are suitable for use through the last day of the month of expiration. Tubes used beyond the expiration date cannot be relied upon to give accurate results.

To guarantee the validity of the tube expiration date, Sensidyne™ tubes should always be stored in the original package at room temperature. A note on the package indicates a maximum storage temperature of 25°C (77°F). Excessively low (less than 35°F) or high (greater than 77°F) temperatures during storage will be avoided, and the tubes will not be subjected to light for prolonged periods.

Detector tubes are tested according to National Institute for Occupational Safety and Health (NIOSH) method TCA/A-012, "Certification Requirements for Gas Detector Tube Units," for the Safety Equipment Institute certification program. Furthermore, each manufacturer's detector tubes are tested as a unit by an independent third party laboratory accredited by the American Industrial Hygiene Association (AIHA).

The Sensidyne™ one-stroke pump and tubes require no general maintenance.

3.3 HMX 271 COMBUSTIBLE GAS INDICATOR

The HMX 271 combustible gas indicator will be used to measure the LEL in work areas. The LEL of a combustible gas or vapor is the lowest concentration by volume in air which will explode when there is an available ignition source. During field activities that can potentially generate sparks, such as drilling or welding, the breathing zone and the air in and around the borehole or well will be periodically monitored with the HMX 271 combustible gas indicator. Furthermore, during field activities around enclosed spaces the breathing zone will also be monitored for the presence of combustible gases and vapors.

The HMX 271 combustible gas indicator takes continuous and simultaneous measurement of combustible gases, oxygen levels, and hydrogen sulfide concentrations. The HMX 271 should be calibrated with pentane according to the user's manual prior to field work each day.

If the HMX 271 is used to measure hydrogen sulfide, it will first be calibrated with the appropriate calibration gas.

The HMX 271 combustible gas indicator will be maintained in the field by wiping the unit clean after every use, storing the unit in a safe protected case, and recharging the battery on a daily basis or as use dictates.

3.4 HYDAC™ CONDUCTIVITY, TEMPERATURE, PH METER

General water quality parameters will be periodically tested during well development and groundwater sampling using a Hydac™ conductivity, temperature, pH meter, or equivalent. The Hydac™ conductivity, temperature, pH meter will be calibrated according to the user's manual each day prior to use. The meter will be recalibrated periodically during days of extended use.

3.5 WATER LEVEL INDICATOR

The depth to groundwater will be measured in each monitoring well with an electric water level indicator. Depth to water will be measured from the top of casing and recorded in the field logbook.

The fiberglass tape on the water level indicator may stretch over extended periods of use. Therefore, the accuracy of the water level indicator will be checked in the field against a calibrated steel measuring tape. Calibration of water level indicator(s) will be performed once prior to use.

The following procedures will be followed for proper maintenance of the water level indicator:

1. Keep probe clean and free of silt or mud. Rinse after every use. The probe on the water level indicator must be thoroughly rinsed with deionized water prior to

taking each water level measurement. This procedure will prevent cross contamination at the site. If gross contamination is observed on the water level indicator probe, it will be washed with Alconox and water and a paper towel or scrub brush.

2. Before sending the unit to the field, make sure it is functioning properly. If not, replace batteries and try again. If water level indicator is still not functioning properly, send back to manufacturer for repair.

3.6 FIELD EQUIPMENT CALIBRATION

Before use, field monitoring instruments will be calibrated on a schedule according to the manufacturer's specifications. A copy of the operations manual will be kept with all field monitoring equipment. The operator must understand the limitations of each instrument and the possible sources of error. Furthermore, the operator must ensure that the equipment is in good working order and functioning properly. All calibration activities will be noted in a calibration logbook. Calibration methods and frequencies are listed in Table 3.1.

3.7 EQUIPMENT MAINTENANCE

Equipment to be used during field sampling will be examined to certify that it is in proper operating condition. This includes checking the manufacturer’s operating manual and the instructions for each instrument to ensure that all maintenance requirements are being observed. Field notes for previous sampling trips will be reviewed so that the notations on any prior equipment problem are not overlooked and all necessary repairs to equipment have been carried out.

Equipment, instruments, tools, gauges, and other items requiring preventive maintenance will be serviced in accordance with the manufacturer’s specified recommendations and written procedures developed by the operators.

Manufacturer’s procedures identify the schedule for servicing critical items in order to minimize the downtime of the measurement system. It will be the responsibility of the operator to adhere to the maintenance schedule and to arrange any necessary and prompt service as required. Service to the equipment, instruments, tools, gauges, etc., will be performed by qualified personnel. In the absence of any manufacturer’s recommended maintenance criteria, a maintenance procedure will be developed by the operator based upon experience and previous use of the equipment.

Logs will be established to record maintenance and service procedures and schedules. All maintenance records will be documented and traceable to the specific equipment, instruments, tools, and gauges.

Table 3.1 Calibration Methods and Frequency

Parameter	Equipment	Calibration	Source of Calibration Standards	Equipment Maintenance	Equipment Decontamination
Volatile organic compounds (VOC)	Photoionization detector (PID)	Daily according to manufacturer's instructions with ambient air (considered 0 mg/L) and isobutylene gas (100 mg/L).	Commercially available, premixed, in cylinders.	Avoid prolonged use in humid environments; keep probe away from dirt or free water; recharge battery.	Replace instrument filter; clean lamp.
VOC	OVA	Daily, and every 2-3 hours during use, methane in air.	Scott specialty gases.	Charge batteries, keep probe out of liquids.	Not applicable.
Explosive gases	Combustible gas indicator	Daily with known gas and concentration; daily testing in known explosive environment (gas tank) and zero adjustment in clean environment.	Commercially available, battery.	Keep inlet away from dirt or free liquids, recharge battery.	Not applicable.
pH	Hydac pH temperature and conductivity meter	Daily with known pH buffer solutions.	Commercially available.	Keep instument face dry. Replace battery when necessary.	Squirt pH probe with water after every use.
Conductivity	Hydac pH, temperature, and conductivity meter	Daily with solution of known conductance.	Commercially available.	Keep instrument face dry. Replace battery when necessary.	Clean sample cup with water and paper towel after every use.
Water level in well	Water level indicator	Check against steel tape.	Commercially available.	Replace battery when necessary.	Squirt probe with water after every use.

3.8 INSTRUMENT DECONTAMINATION

Instrument decontamination will be performed on equipment that comes in direct contact with soil or water samples. Refer to Section 1.5 of this plan for proper decontamination procedures or the manufacturer's operating manual specified recommended procedures.

SECTION 4
FIELD QA/QC PROGRAM

This section is a summary of the field QA/QC program, covering identification and description of control parameters used during field operations, acceptance criteria for each parameter controlled, and corrective actions required for field or laboratory personnel in the event control limits are exceeded.

4.1 CONTROL PARAMETERS

During sampling activities, three types of field QA/QC samples will be collected, as described in Section 2.4. In addition, the following samples will be collected for laboratory QA/QC:

1. One trip blank will accompany every cooler of soil and water samples sent to the laboratory for the analysis of volatile organic compounds. The trip blank will be analyzed for VOCs only.
2. One equipment rinsate blank will be taken by for every twenty environmental samples collected. This blank will be analyzed for the same chemical constituents as all environmental samples collected at the site.
3. Field duplicates will collected at a rate of one for every ten environmental samples. Duplicate samples will be analyzed for the same constituents as the original in the laboratory.
4. One set of MS/MSDs will be collected at a rate of one set for every twenty environmental samples.

Monitoring instruments used in field activities will be calibrated, adjusted, and maintained according to the manufacturer's specifications at specific intervals to maintain accuracy within necessary limits. The field equipment calibration, adjustment and maintenance procedures and schedules are discussed in Section 3. Equipment calibration and maintenance will be documented in the field logbook.

4.2 CONTROL LIMITS FIELD SAMPLING PLAN

This section specifies the methods used to collect and document the samples collected from the site. Samples will be collected for various purposes including planning and confirmation and will be documented accordingly.

4.3 CORRECTIVE ACTIONS

Corrective actions for field measurements are listed in Table 4.1. If control limits are exceeded during calibration and maintenance of field monitoring instruments, corrective action will be taken. Corrective action plans are discussed in the QAPP. In the event that field QA/QC control limits are exceeded, the field logbook will document exceedance of criteria and discuss subsequent corrective actions.

4.4 RECORD KEEPING

4.4.1 Field Logbooks

All information (except drill logs) pertinent to field activities (including instrument calibration data) will be recorded daily in program-numbered and project-designated field logbooks. These books will be bound, and pages will be consecutively numbered. Entries in the logbook will be made in ink, and each page will be signed and dated. At a minimum, the following information will be included in the field logbooks:

- Name and title of author, date and time of entry, and environmental conditions during field activity;
- Location of sampling activity;
- Name and title of field crew;
- Summary of equipment preparation procedures including the lot numbers, manufacturer, and expiration dates of buffer and standard solutions used for field instrument calibration;
- Sample media (surface water, soil);
- Sample collection method;
- Number and volume of sample(s) taken and sample identification numbers;
- Date and time of collection;
- Sample distribution (laboratory);
- Field observations;
- Any field measurements made such as temperature;
- Health and safety information such as personnel air monitoring, heat or cold stress monitoring data, upgrades or downgrades of personnel protective equipment, and the reasons for such upgrades or downgrades; and
- All sample document, such as dates and methods of sample shipments and sampling handling (preservation).

In addition, the following observations about each sample collected will be recorded in the logbooks as appropriate:

Table 4.1 Control Parameters, Control Limits, and Corrective Actions

Measurement Parameter	Control Checks	Control Limits	Corrective Actions*
pH	Measure buffer pH at least following every other measurement.	Buffer measurements within 0.2 units of actual values.	Recalibrate pH meter; check batteries and probe condition.
Electrical conductance	Measure standard daily.	±10 percent of actual value.	Replace or replatinize probe; verify that meter zeros and red-lines properly; check batteries.
Temperature	Check measurement.	±1°C	Replace thermometer or correct temperature readings.
Volatile organics (photoionization detector)	Measure standard gas at least daily.	±5 percent	Replace dust filter; clean lamp; check battery.
Explosive gases	Measure calibration standard daily; test periodically in known explosive environment (gas tank) and check zero in clean environment.	Adjust meter to read exact standard value. Control limit for fresh air is ±1 percent.	Recalibrate meter; check battery; replace sensor.
Water level (water level indicator)	Measure weekly against tape measure when in regular use.	±0.02 feet	Replace meter tape.

* Required if control limits not achieved.

- Sample depth,
- Color and physical description,
- Type(s) of laboratory analyses requested, and
- Any changes in sampling locations (also to be indicated on annotated maps).

In summary, sufficient information will be recorded in the field logbooks during field activities to permit reconstruction of the sampling event without reliance on the collector's memory.

If an error is made, the individual will make corrections simply by crossing a line through the error, initialing, dating, and entering the correct information. The erroneous information should not be obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All corrections must be initialed and dated.

4.4.2 Geological Logs

All drill logs will subscribe to the following requirements:

- Logs will be prepared in the field as borings and wells are drilled by a qualified, experienced geologist, soil scientist, or hydrologist. Each log will be signed by the preparer.
- All log entries will be printed. Photo reproductions will be clear and legible. Illegible or incomplete logs will not be accepted.
- Borehole depth information will be from direct measurements accurate to 0.1 foot.
- Logs will be prepared on the attached sheets (see Appendix A) or similar boring or drilling log.
- All relevant information blanks in the log heading and log body will be completed. If surveyed horizontal control is not available at the time of drilling, location sketches referenced by measured distances or prominent surface features will be shown on or attached to the log.
- Log scale will be approximately 1 inch = 1 foot for soil borings.
- Each and every material type encountered will be described in the log form.
- Unconsolidated materials will be described as follows:
  - Descriptive USCS classification,
  - Consistency of cohesive materials or apparent density of noncohesive materials,
  - Moisture content assessment, e.g., dry, moist, wet,
  - Color, and

   - Other descriptive features (bedding characteristics, organic materials, macrostructure of fine-grained soils, e.g., root holes, fractures, etc.).

- Rock materials will be described in accordance with standard geologic nomenclature for:
   - Rock type,
   - Relative hardness,
   - Texture,
   - Color,
   - Weathering,
   - Bedding,
   - Fractures, joints, bedding planes, and cavities, including any filling materials if present, and
   - Other descriptive features (fossils, pits, crystals, etc.).

- Stratigraphic or lithologic changes will be identified by a solid horizontal line at the scale depth on the log's classification section which corresponds to measured borehole depths at which changes occur, measured and recorded to the nearest 0.1 foot. Gradational transitions, changes identified from cuttings, or methods other than direct observation and measurement will be identified by a horizontal dashed line at the appropriate scale depth based on the best judgment of the logger.

- Logs will clearly show the depth intervals from which all samples are retained.

- Logs will identify the depth at which water is first encountered, the depth to water at the completion of drilling, and the stabilized depth to water. The absence of water in borings will also be noted. Stabilized water level data will include time allowed for levels to stabilize.

- Logs will show borehole and sample diameters and depths at which drilling or sampling methods or equipment change.

- Logs will show total depth of penetration and sampling. The bottom of the hole will be identified on the log by solid lines from margin to margin with a notation as to the total depth drilled.

- Logs will show drilling fluids used, if necessary, including:
   - Source of water,
   - Drill fluid additives by brand and product name, and mixture proportions, and
   - Type of filter for compressed air.

- Logs will identify any intervals of hole instability.

- Intervals of lost bedrock core will be shown. Intervals of intact soil sampling attempts will also be noted, including depths from which attempts were made and length of sample recovered from each attempt. Bedrock coring information will be recorded in consecutively numbered runs and will include the following:
  - Depth to top and bottom of each core run, and
  - Length of core recovered from each run.
- Any special drilling or sampling problems will be recorded on logs, including descriptions of problem resolutions.
- Logs will contain all other information relevant to a particular investigation, including but not limited to:
  - Odors,
  - PID/OVA measurements or other field screening or test results, and
  - Any observed evidence of contamination in samples, cuttings, or drilling fluids.

Copies of the field logs will be included in the final report. All core that is obtained will be photographed in such a manner that the top depth, bottom depth, and boring number for each section of core are legible within the photo. An example of a geologic boring log is located in Appendix A.

4.4.3 Project Change Records

The FSP for this investigation is a working document; thus, changes or revisions to the FSP or field changes may be necessary at any time during the investigation. These changes may be attributable to field conditions, data evaluation, personnel changes, contracting, or any number of unforeseen circumstances. Minor changes, such as moving a boring or sampling location in the same vicinity as originally planned, will be documented in the field. Minor changes will likely require implementation prior to notification to the CSSA point of contact. The field team leader or task manager will document minor changes, and the date the change was implemented, in the field logbook. Changes should be very specific and reference the FSP or WP page number, figure number, and any specific wording to be changed.

Major changes to the planned investigation, such as putting in optional borings, adding or eliminating tasks, or changing or modifying analytical methods, will require notification and approval before implementation. A formal modification request will be submitted to AFCEE, AMC, and CSSA. All changes will be approved by the appropriate authorities prior to implementation.

4.5 SITE MANAGEMENT

The installation point of contact (POC) is Brian Murphy (telephone number 210/698-5208). The Air Force Center for Environmental Excellence (AFCEE) technical project manager is Jo Jean Mullen (telephone number 210/536-5940).

CSSA will provide Parsons ES personnel and their subcontractors with contractors' passes, at the main gate each day before entering CSSA. Parsons ES will provide written notification of the names, dates of birth, and social security numbers of all personnel scheduled to work on-site. This information will be provided to CSSA at least two weeks before any field work is to be performed.

A paved area and large quantities of potable water must be available for use at CSSA for decontamination by Parsons ES personnel and their subcontractors. A 110/115-volt AC electrical outlet must be available within 25 feet of the paved area for steam cleaner hookup.

The post will assign accumulation points to which Parsons ES can deliver any drill cuttings or well development/purging fluids which are suspected to be hazardous.

SECTION 5
REFERENCES

AFCEE, 1996. *AFCEE Quality Assurance Project Plan, Version 1.1.* Brooks Air Force Base, Texas, February, 1996.

AFCEE, 1993. *Air Force Center for Environmental Excellence (AFCEE) Handbook for the Installation Restoration Program (IRP) Remedial Investigation and Feasibility Studies (RI/FS),* Environmental Service Directorate, Brooks Air Force Base, Texas, September, 1993.

ASTM, 1992. *Standard Practice for Design and Installation of Groundwater Monitoring Wells in Aquifers,* D5092-90, ASTM Standards on Groundwater and Vadose Zone Investigations, 1992.

Driscoll, 1986. *Groundwater and Wells*, second edition, Fletcher G. Driscoll, Ph.D., Johnson Filtration Systems Inc., St. Paul, Minnesota.

EPA, 1987. *Compendium of Superfund Field Operations Methods*. USEPA.

EPA, 1991. *Management of Investigation-Derived Wastes During Site Inspections*, EPA/540/G-91/009, May 1991.

EPA, 1992. *RCRA Groundwater Monitoring: Draft Technical Guidance*, EPA/530-R-93-001, PB 93-139350, November 1992.

Engineering-Science, 1992. *Field Services Manual*, Engineering-Science, Inc., August 1992.

Parsons ES, 1995. *Health and Safety Plan for Closure of Solid Waste Management Units at Camp Stanley Storage Activity, Texas*. December, 1995.

APPENDIX A

EXAMPLES OF FIELD LOG FORMS

and

MAP 1

Appendix D
Lead Bioaccessibility from Amended Soils
Camp Stanley Storage Activity, Texas

Lead Bioaccessibility from Amended Soils: Camp Stanley, Texas

Prepared for

UFA Ventures, Inc.
Carlsbad, New Mexico

Exponent®

Lead Bioaccessibility from Amended Soils: Camp Stanley, Texas

Prepared for

UFA Ventures, Inc.
403 West Riverside Drive
Carlsbad, New Mexico 88220

Prepared by

Exponent
4940 Pearl East Circle, Suite 300
Boulder, Colorado 80301

August 2003

Doc. no. BO02479.001 0101 0603 R048

Contents

Background

It is generally known that metals typically exhibit low bioavailability from soil matrices (Allen and Huang 1994; Dreesen and Williams 1982; Ruby et al. 1999). Thus, a particular data need for assessing human health risks from exposure to metals in soil is the bioavailability of the specific metal in soil, as compared to the more soluble forms that generally serve as the basis of the toxicity reference values and cancer slope factors. However, the amount of an element in soil that is available for absorption in the human digestive system can vary (e.g., for lead, from 1% to 90% relative to soluble forms [Ruby et al. 1999]), making estimation of bioavailability for a particular site difficult without directly testing site-specific environmental media.

Traditionally, toxicologists have used animal studies (termed *in vivo* tests, meaning that they occur within a living animal) to measure the amount of lead that would be bioavailable from a particular material. However, enough is currently known about how lead becomes bioavailable that *in vitro* studies (i.e., studies that occur in an artificial environment) can be used to estimate lead bioavailability (Ruby et al. 1999; Drexler 2003). This *in vitro* approach was used to estimate the reduction in oral lead bioavailability for soils from the Camp Stanley site that had been amended with Apatite II.

Simple *in vitro* extraction tests have been used for several years to assess the degree of metal dissolution in a simulated gastrointestinal-tract environment (Ruby et al. 1993, 1996; Medlin 1997). Such tests mimic the temperature, pH, and acidic fluid conditions of the gastric compartment to yield estimates of the amount of a metal in soil that is bioaccessible (i.e., will be soluble and available for absorption).[1] For example, the European Standard for Safety of Toys (CEN 1994) provides for an extraction test (2-hour extraction in pH 1.5 [HCl] fluid) to evaluate the bioaccessibility of eight metals (antimony, arsenic, barium, cadmium, chromium, lead, mercury, and selenium) from children's toys. This method has been used since 1994 by the 18 member countries of the Comite European de Normalization (CEN) to regulate the safety of toys.

A considerable amount of work has been performed to develop simple, reproducible extraction tests that can predict the oral bioavailability of lead in animal models (Ruby et al. 1993, 1996; Medlin 1997). At a recent U.S. Environmental Protection Agency (EPA) workshop on this topic (held April 15 and 16, 2003, in Tampa, Florida), data were presented that indicated a strong *in vitro*–to–*in vivo* correlation between a standardized *in vitro* extraction method and the EPA Region VIII juvenile swine model. The *in vitro* extraction method used in the EPA method validation study, which was developed by the Solubility/Bioavailability Research Consortium (SBRC), is presented in Attachment 1, and was used in this study. The only deviation from this *in vitro* protocol was that the gastric pH was raised from 1.5 to 2.3. This was done because studies at the Joplin, Missouri, site have indicated that an extraction pH value of 2.3 most accurately predicts reductions in lead bioavailability for phosphate-amended soils, based on comparison to the Region VIII juvenile swine model (Ruby et al. 2002; Ryan 2003).

---

1 Bioaccessibility refers to the fraction of an element that will be soluble in the gastrointestinal tact, and is therefore available for absorption. Once absorbed, the element is considered to have been bioavailable.

This report provides the results of *in vitro* testing of lead bioaccessibility from eleven soil samples collected at the Camp Stanley site in Texas. The soils tested included those amended with Apatite II, and unamended (i.e., control) soils, to assess potential reductions in lead bioaccessibility. Included is information regarding the preparation of site samples for analyses, the analytical methods used to assess lead bioaccessibility, and the results and implications of the bioaccessibility testing.

Methods

The following sections describe the manner in which the soil samples were prepared for analysis, the methods by which the bioaccessibility analyses were performed, and the results of these analyses. Sample preparation and bioaccessibility extractions were performed in Exponent's laboratory in Boulder, Colorado. Analyses for total lead concentration in the soil samples and extraction fluids were conducted at the Department of Geologic Sciences, University of Colorado at Boulder.

Sample Preparation and Analysis

The samples consisted of two soils from laboratory amendment testing and nine soils from field testing. Each of the amended soils had been amended with 5% by weight of Apatite II. The control and amended laboratory soils (CSSA-1UN and CSSA-2AP5, respectively) had already been sieved to <250 μm. The soils from field amendment testing consisted of three soils from the control (unamended) plot (labeled B-20 Untreated), three soils from the Phase I field demonstration (labeled B-20 Phase I), and three soils from the Phase II field demonstration (labeled B-20 Phase II). The untreated and Phase II soils were each sieved to both <2 mm and <250 μm, and both size fractions were subjected to bioaccessibility testing, to establish whether these different size fractions would yield different bioaccessibility results. For the laboratory and Phase I field soils, only the <250-μm size fraction was tested. It should be noted that the <250-μm soil size fraction is generally used for bioaccessibility testing, because it is believed to represent the fraction of soil that is most likely to adhere to human hands and become ingested during hand-to-mouth activity (Maddaloni et al. 1998; U.S. EPA 1999). Each soil sample was divided into equivalent aliquots, with one split used for total lead analysis, and a second split subjected to bioaccessibility testing. As a quality control measure, all soil samples were submitted in duplicate for total lead analysis.

Bioaccessibility Testing

The sieved soil samples (<250-μm and <2-mm size fractions) were subjected to bioaccessibility testing according to the Standard Operating Procedure (SOP) developed by the Solubility/Bioavailability Research Consortium (SBRC). This protocol is provided as Attachment 1. As described in the Background section, an extraction pH of 2.3, rather than the 1.5 specified in the SOP, was used. This was done because studies at the Joplin, Missouri, site have indicated that an extraction pH of 2.3 most accurately predicts reductions in lead bioavailability for phosphate-amended soils, based on comparison to the Region VIII juvenile swine model (Ruby et al. 2002; Ryan 2003). The testing included analysis of all soil samples in triplicate and analysis of a Standard Reference Material (SRM) from the National Institute of Standards and Technology (NIST) (SRM 2711, Montana Soil). The SRM had previously been run through the *in vitro* testing procedure on a number of occasions, and was included in this study to evaluate whether the testing procedure was providing consistent results. The QA samples specified in the *in vitro*

testing SOP (i.e., blanks and spikes) were run at the specified frequency. The duplicate tests specified in the SOP were omitted, because all of the test samples were analyzed in triplicate.

Bioaccessibility of lead or arsenic is calculated in the following manner:

$$Bioaccessibility = \frac{(concentration\ in\ the\ in\ vitro\ extract,\ mg/L)(0.1\ L)}{(concentration\ in\ the\ soil,\ mg/kg)(0.001\ kg)} \times 100 \qquad \text{(Eq. 1)}$$

Analytical Methods

All solid and fluid samples were delivered for analysis to the Department of Geological Sciences, University of Colorado at Boulder, under chain of custody. Total lead concentrations in solid samples were determined by digestion according to EPA SW-846 Method 3050 (U.S. EPA 1997) and analysis by inductively coupled plasma/mass spectroscopy (ICP/MS; EPA Method 200.8; U.S. EPA 1999). Total lead concentrations in the *in vitro* extracts were determined by ICP/MS (EPA Method 200.8; U.S. EPA 1999).

Results

Lead Concentrations

Data on lead concentrations in the sieved samples from the Camp Stanley site are provided in Table 1. Total lead concentrations were quite variable between aliquots of the same sample, and the variability was most pronounced for the samples that had been sieved to <2 mm. To help resolve this issue, additional aliquots of the samples with the greatest variability were submitted for total lead analysis (up to six replicates of a single sample were eventually analyzed). The variability in total lead results is believed to occur due to a "nugget" effect, wherein lead is present as discrete nuggets in the soil samples. The reproducibility for total lead results on the <250-μm samples is generally acceptable (relative percent difference [RPD] on duplicate samples of <10%). In contrast, the reproducibility on the <2-mm samples was often quite large, with up to 10-fold variation observed for replicate samples. As a result, the calculated bioaccessibility values for the <2-mm samples are of questionable reliability.

Lead Bioaccessibility

The results from the *in vitro* extraction of site samples (Table 2) indicate that the average bioaccessibility of lead from the amended and unamended laboratory samples were 71% and 98%, respectively (calculated according to equation 1). Lead bioaccessibility values that were calculated to be greater than 100% were rounded down to the theoretical maximum of 100% prior to calculating averages. The coefficient of variation (CV; calculated as standard deviation/mean × 100) for these triplicate analyses were 4.9% and 2.2%, respectively, indicating good reproducibility on these triplicate analyses. These results yield a 28% reduction in lead bioaccessibility for the laboratory samples amended with Apatite II (Figure 1), calculated as follows:

$$\frac{98\% - 71\%}{98\%} = 28\% \qquad \text{(Eq. 2)}$$

For the unamended field samples, average lead bioaccessibility was 69% and 82% for the <2-mm and <250-μm size fractions, respectively. The *in vitro* analyses of <2-mm-size material produced a CV of 47%, which likely reflects the same heterogeneity in lead distribution as was observed with the total lead results. The CV for the <250-μm samples was considerably less, at 20%. The Phase I amended soils yielded an average bioaccessibility of 58% (CV of 24%), which when compared to the results for unamended field soils, equates to a 29% reduction in lead bioaccessibility (Figure 1).

The <2-mm and <250-μm soil fractions from the Phase II amended soils produced average bioaccessibility values of 31% and 61%, respectively. These results indicate reductions in lead bioaccessibility of 55% and 26%, respectively, for these two size fractions. However, the CV values resulting from analysis of the <2-mm samples were 47% (unamended soils) and 41%

(amended soils), indicating a considerable degree of variability in these analyses. This variability most likely reflects the presence of lead as discrete nuggets of material in the larger soil size fraction. In contrast, the CV values for the <250-μm fraction were 20% and 7.8% for the unamended and amended soils, respectively. As a result, the data from *in vitro* testing on <250-μm samples are considered more reliable than the results from the <2-mm material, as estimates of bioavailability reduction subsequent to amendment with Apatite II.

Quality Assurance Sample Results

Total lead concentration in SRM 2711 was analyzed in duplicate, producing an average value of 1,154 mg/kg. The certified value is 1,162 mg/kg (Table 3), indicating a 99% recovery for lead in this SRM. When subjected to the *in vitro* test, SRM 2711 produced 9.04 mg/L of lead in the extraction solution (Table 2), which is consistent with previous analyses of this sample (see Table 1 of Attachment 1). Although the reagent blanks slightly exceeded their control value of 0.025 mg/L lead, none of the method blanks exceeded their control value of 0.050 mg/L lead (Table 3). Given the elevated lead concentrations produced by all of the extracted samples (Table 2), the slight exceedances in the reagent blank concentrations will not affect the test results. Finally, the lead spike solutions run through the *in vitro* extraction yielded acceptable results, with 99% to 103% recovery (Table 3).

Comparison to Results in Adult Humans

In a series of studies at Columbia School of Public Health, lead-bearing soils were fed to adult human volunteers, and lead bioavailability was established based on stable lead isotope dilution in blood (Maddaloni et al. 1998). In one such study, a soil from Joplin, Missouri, which had been amended with 1% phosphorous, as phosphoric acid, and allowed to weather in the environment for 18 months, was dosed to human volunteers. Results from this amended soil, when compared to its unamended counterpart, indicated a reduction in lead bioavailability of 69% (Graziano et al. 2001). However, when these same amended and unamended soils were evaluated using an *in vitro* test (identical to the one used in this study), the estimated reduction in lead bioavailability was only 38% (Graziano et al. 2001). These results suggest that the *in vitro* test (at a pH of 2.3) underpredicts lead bioavailability reductions that occur in adult humans.

Based on the above results, the extent of this underprediction is close to two-fold

$$38\% \div 69\% = 0.55$$

As discussed above, the amended materials from the Phase II field study, <250-μm size fraction, are believed to be most representative of the Camp Stanley site. This material produced an estimated reduction in lead bioavailability of 26% (Figure 1) from the *in vitro* test. Adjusting this value to be more representative of adult humans using the Graziano et al. (2001) comparison would yield a reduction in lead bioavailability of 47%:

$$26\% \div 0.55 = 47\%$$

Therefore, for Camp Stanley soils amended with 5% by weight of Apatite II, a lead bioavailability reduction of approximately 47% is considered an appropriate value for adult humans.

Conclusions

Eleven soil samples from the Camp Stanley site were evaluated using an *in vitro* extraction test to estimate reductions in lead bioavailability resulting from amendment with Apatite II.

The results of this study indicate that:

- Lead bioaccessibility was consistently reduced in the amended soils, relative to the unamended soils.
- Results from soils sieved to <2 mm showed much greater reduction in bioaccessibility but also showed much greater variability than those sieved to <250 μm, most likely due to nuggets of lead present in the coarser size fraction. As a result, data from the <250-μm fraction are considered more reliable.
- *In vitro* test results from the Phase II field trial, <250-μm size fraction, which are considered to be most representative of the Camp Stanley site, yielded an estimate of 26% lead bioavailability reduction.
- Comparison of the *in vitro* study results to those from a study of lead bioavailability reduction in adult humans suggests that amendment of Camp Stanley soils (carbonate soils with a soil pH of 8.3) with Apatite II should produce a 47% reduction in lead bioavailability for adult humans. Soils with different chemistries will exhibit greater or lesser degrees of reduction after amendment with Apatite II, depending on their chemistry.

References

Allen, H.E., and C.P. Huang. 1994. Metal speciation and contamination of soil. Lewis Publishers, Inc., Boca Raton, Florida. 336 pp.

Dreesen, D.R., and J.M. Williams. 1982. Mobility and bioavailability of uranium mill tailings contaminants. Environ. Sci. Technol. 16:702–709.

Drexler, J. 2003. Bioassays: Past and future. Presentation at the U.S. EPA Bioavailability Workshop. April 15, 2003, in Tampa, Florida.

Graziano, J.H., N.J. LoIacono, M. Maddaloni, and C.C. Blum. 2001. Assessing the oral bioavailability of lead in soil to humans. Presentation at the 40th Annual Meeting of the Society of Toxicology, March 28, 2001.

Maddaloni, M., N. LoIacono, W. Manton, C. Blum, J. Drexler, and J. Graziano. 1998. Bioavailability of soilborne lead in adults by stable isotope dilution. Env. Health Persp. 106(6):1589–1594.

Medlin, E.A. 1997. An *in vitro* method for estimating the relative bioavailability of lead in humans. Master's Thesis, Department of Geological Sciences, University of Colorado at Boulder.

Ruby, M.V., A. Davis, T.E. Link, R. Schoof, R.L. Chaney, G.B. Freeman, and P. Bergstrom. 1993. Development of an in vitro screening test to evaluate the *in vivo* bioaccessibility of ingested mine-waste lead. Environ. Sci. Technol. 27(13):2870–2877.

Ruby, M.V., A. Davis, R. Schoof, S. Eberle, and C.M. Sellstone. 1996. Estimation of lead and arsenic bioavailability using a physiologically based extraction test. Environ. Sci. Technol. 30(2):422–430.

Ruby, M.V., R. Schoof , W. Brattin, M. Goldade, et al. 1999. Advances in evaluating the oral bioavailability of inorganics in soil for use in human health risk assessment. Environ. Sci. Technol. 33(21):3697–3705.

Ruby, M.V., S.L. Brown, K.G. Scheckel, and D. Allen. 2001. Effects of treatments on soil-lead bioavailability: Implications of in vitro extraction testing. Presentation at the Soil Society of America Annual Meeting, October 24, 2001.

Ryan, J. 2003. Soil lead bioavailability. Presentation at the U.S. EPA Bioavailability Workshop, April 16, 2003 in Tampa, Florida.

U.S. EPA. 1997. Test methods for evaluating solid waste – physical/chemical methods, SW-846. Version 2.0. U.S. Environmental Protection Agency, Washington, DC.

U.S. EPA. 1999a. IEUBK model bioavailability variable. U.S. Environmental Protection Agency, Technical Review Workgroup for Lead.

U.S. EPA. 1999b. Methods and guidance for analysis of water. EPA-821-C-99-004. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Figures and Table

Table 1. Total lead in soils, in vitro bioaccessibility testing, Camp Stanley

Sample	Replicate	Pb Concentration (mg/kg)	Average Pb Concentration (mg/kg)
Refeference Material			
SRM 2711	1	1,156	
	2	1,152	**1,154**
< 250 µm Material			
CSSA-1UN	1	46,435	
	2	38,646	
	3	72,137	
	4	45,815	
	5	45,755	
	6	47,134	**49,320**
CSSA-2AP5	1	43,578	
	2	42,319	**42,949**
B-20 Untreated - 1	1	7,753	
	2	8,833	**8,293**
B-20 Untreated - 2	1	11,379	
	2	12,539	**11,959**
B-20 Untreated - 3	1	9,979	
	2	9,479	**9,729**
B-20 Phase I - 1	1	1,918	
	2	1,910	**1,914**
B-20 Phase I - 2	1	563	
	2	592	
	3	693	**616**
B-20 Phase I - 3	1	556	
	2	590	**573**
B-20 Phase II - 1	1	2,538	
	2	1,866	**2,202**
B-20 Phase II - 2	1	1,406	
	2	1,311	**1,358**
B-20 Phase II - 3	1	1,357	
	2	1,221	**1,289**
<2 mm Material			
B-20 Untreated - 1	1	8,446	
	2	8,173	**8,309**
B-20 Untreated - 2	1	4,955	
	2	4,970	
	3	15,996	
	4	4,905	**7,706**
B-20 Untreated - 3	1	5,443	
	2	6,261	
	3	9,556	**7,087**

Table 1. (cont.)

Sample	Replicate	Pb Concentration (mg/kg)	Average Pb Concentration (mg/kg)
<2 mm Material (cont.)			
B-20 Phase II - 1	1	1,214	
	2	908	
	3	11,873	
	4	1,459	**3,863**
B-20 Phase II - 2	1	13,569	
	2	570	
	3	2,021	
	4	915	
	5	638	**3,543**
B-20 Phase II -3	1	1,313	
	2	654	**983**

Table 2. Results from in vitro bioaccessibility testing of soil samples from Camp Stanley

Soil Sample ID	Lead Conc. in Substrate (mg/kg)	Mass of Soil Tested (g)	Mass of Lead in Soil Extracted (mg)	Extraction Date	pH (s.u.)	Lead Conc. in Extract (mg/L)	Volume of Extract (L)	Mass of Lead in Extract (mg)	Individual Lead Bioaccessibility (%)	Average Lead Bioaccessibility
Lab Samples										
Unamended										
<250 µm										
CSSA-1UN	49,320	0.9943	49.0	5/2/03	2.61	494	0.100	49.4	100 (101)[a]	98%
CSSA-1UN	49,320	0.9965	49.1	5/2/03	2.64	486	0.100	48.6	99	CV = 1.9%
CSSA-1UN	49,320	1.0146	50.0	5/2/03	2.64	482	0.100	48.2	96	
Amended										
<250 µm										
CSSA-2AP5	42,949	1.0019	43.0	5/2/03	2.63	318	0.100	31.8	74	71%
CSSA-2AP5	42,949	1.0002	43.0	5/2/03	2.62	288	0.100	28.8	67	CV = 4.9%
CSSA-2AP5	42,949	0.9944	42.7	5/2/03	2.61	306	0.100	30.6	72	
Field Samples										
Unamended										
<2 mm										
B-20 Untreated - 1	8,309	1.0115	8.41	4/30/03	2.44	42.7	0.100	4.27	51	
B-20 Untreated - 1	8,309	1.0081	8.38	4/30/03	2.47	36.0	0.100	3.60	43	
B-20 Untreated - 1	8,309	1.0095	8.39	4/30/03	2.50	8.9 [b]	0.100	0.89	11	
B-20 Untreated - 2	7,706	0.9985	7.7	4/30/03	2.51	73.9	0.100	7.39	96	69%
B-20 Untreated - 2	7,706	1.0019	7.7	4/30/03	2.53	36.1 [b]	0.100	3.61	47	
B-20 Untreated - 2	7,706	1.0154	7.8	4/30/03	2.55	57.3	0.100	5.73	73	CV = 47%
B-20 Untreated - 3	7,087	1.0288	7.29	4/30/03	2.54	70.8	0.100	7.08	97	
B-20 Untreated - 3	7,087	1.0135	7.18	5/2/03	2.54	94.6	0.100	9.46	100 (132)[a]	
B-20 Untreated - 3	7,087	0.9867	6.99	5/2/03	2.54	71.0	0.100	7.10	100 (102)[a]	
<250 µm										
B-20 Untreated - 1	8,293	0.9881	8.19	5/2/03	2.60	54.7	0.100	5.47	67	
B-20 Untreated - 1	8,293	1.0061	8.34	5/2/03	2.59	53.8	0.100	5.38	64	
B-20 Untreated - 1	8,293	0.9909	8.22	5/2/03	2.58	47.3	0.100	4.73	58	
B-20 Untreated - 2	11,959	1.0118	12.1	5/2/03	2.61	105	0.100	10.5	87	82%
B-20 Untreated - 2	11,959	0.9993	12.0	5/2/03	2.61	98.1	0.100	9.81	82	
B-20 Untreated - 2	11,959	1.0142	12.1	5/2/03	2.61	100	0.100	10.0	83	CV = 20%
B-20 Untreated - 3	9,729	1.0183	9.91	5/2/03	2.60	113	0.100	11.3	100 (114)[a]	
B-20 Untreated - 3	9,729	1.0070	9.80	5/2/03	2.59	106	0.100	10.6	100 (108)[a]	
B-20 Untreated - 3	9,729	1.0100	9.83	5/2/03	2.60	122	0.100	12.2	100 (124)[a]	

Table 2. (cont.)

Soil Sample ID	Lead Conc. in Substrate (mg/kg)	Mass of Soil Tested (g)	Mass of Lead in Soil Extracted (mg)	Extraction Date	pH (s.u.)	Lead Conc. in Extract (mg/L)	Volume of Extract (L)	Mass of Lead in Extract (mg)	Lead Bioaccessibility (%)	Average Lead Bioaccessibility
Phase I Amended										
<250 µm										
B-20 Phase I - 1	1,914	0.9986	1.91	4/30/03	2.61	14.8	0.100	1.48	78	
B-20 Phase I - 1	1,914	0.9887	1.89	4/30/03	2.59	13.2	0.100	1.32	70	
B-20 Phase I - 1	1,914	1.0006	1.92	4/30/03	2.59	15.6	0.100	1.56	82	
B-20 Phase I - 2	616	0.9882	0.609	4/30/03	2.57	2.84	0.100	0.284	47	
B-20 Phase I - 2	616	0.9851	0.607	4/30/03	2.56	3.00	0.100	0.300	49	58%
B-20 Phase I - 2	616	1.0130	0.624	4/30/03	2.56	3.11	0.100	0.311	50	CV = 24%
B-20 Phase I - 3	573	1.0278	0.589	4/30/03	2.56	2.91	0.100	0.291	49	
B-20 Phase I - 3	573	1.0106	0.579	4/30/03	2.55	2.84	0.100	0.284	49	
B-20 Phase I - 3	573	1.0034	0.575	4/30/03	2.54	2.82	0.100	0.282	49	
Phase II Amended										
<2 mm										
B-20 Phase II - 1	3,863	0.9830	3.80	4/30/03	2.57	13.1	0.100	1.312	35	
B-20 Phase II - 1	3,863	0.9890	3.82	4/30/03	2.56	9.28	0.100	0.928	24	
B-20 Phase II - 1	3,863	1.0067	3.89	4/30/03	2.55	12.7	0.100	1.27	33	
B-20 Phase II - 2	3,543	0.9942	3.52	4/30/03	2.57	11.5 [b]	0.100	1.15	33	
B-20 Phase II - 2	3,543	1.0046	3.56	4/30/03	2.57	5.14	0.100	0.514	14	31%
B-20 Phase II - 2	3,543	0.9953	3.53	4/30/03	2.59	4.56	0.100	0.456	13	CV = 41%
B-20 Phase II - 3	983	0.9959	0.979	4/30/03	2.57	5.27	0.100	0.527	54	
B-20 Phase II - 3	983	1.0009	0.984	4/30/03	2.58	4.33	0.100	0.433	44	
B-20 Phase II - 3	983	1.0015	0.985	4/30/03	2.48	3.27	0.100	0.327	33	
<250 µm										
B-20 Phase II - 1	2,202	0.9857	2.17	4/30/03	2.41	13.5	0.100	1.35	62	
B-20 Phase II - 1	2,202	1.0032	2.21	4/30/03	2.44	15.1	0.100	1.51	69	
B-20 Phase II - 1	2,202	0.9973	2.20	4/30/03	2.45	12.6	0.100	1.26	58	
B-20 Phase II - 2	1,358	0.9976	1.36	4/30/03	2.51	7.07	0.100	0.707	52	
B-20 Phase II - 2	1,358	0.9964	1.35	4/30/03	2.52	8.76	0.100	0.876	65	61%
B-20 Phase II - 2	1,358	0.9978	1.36	4/30/03	2.52	8.73	0.100	0.873	64	CV = 7.8%
B-20 Phase II - 3	1,289	0.9862	1.27	4/30/03	2.52	8.04	0.100	0.804	63	
B-20 Phase II - 3	1,289	0.9908	1.28	4/30/03	2.53	7.60	0.100	0.760	60	
B-20 Phase II - 3	1,289	0.9818	1.27	4/30/03	2.46	7.47	0.100	0.747	59	
Reference Soil										
SRM 2711	1,154	0.9983	1.152	5/2/03	2.32	9.04	0.100	0.904	78	

[a] Values were adjusted to reflect the theoretical maximum of 100% bioaccessibility; values in parenthesis are actual calculated values.
[b] Average of original and rerun samples

Notes: CV - coefficient of variance = Standard Deviation/Mean X 100
-- - not applicable/not available

Table 3. QA sample results for *in vitro* bioaccessibility testing of lead in soils: Camp Stanley

Sample ID	pH (s.u.)	Lead Conc. in Substrate (mg/kg)	Relative Percent Difference (%)	Lead Spike Concentration (mg/L)	Lead Concentration in Extract (mg/L)	Percent Recovery (%)	Relative Standard Deviation (%)	Control Limits
SRM - Montana Soil 2711								
True Value	--	1,162 [a]	--	--	--	--	--	
Measured Result	--	1,154	--	--	--	99	--	85 – 115%
QC Samples								
Reagent Blank/Extraction Fluid	--	--	--	--	0.0525	--	--	<0.025 mg/L
Reagent Blank/Extraction Fluid	--	--	--	--	0.0471	--	--	<0.025 mg/L
Reagent Blank/Extraction Fluid	--	--	--	--	0.0506	--	--	<0.025 mg/L
Method Blank		--	--	--	0.0238	--	--	<0.50 mg/L
Method Blank		--	--	--	0.0220	--	--	<0.50 mg/L
Method Blank		--	--	--	0.0331	--	--	<0.50 mg/L
Lead Spike Solution	--	--	--	10.0	10.1	101	--	85 – 115%
Lead Spike Solution	--	--	--	10.0	9.9	99	--	85 – 115%
Lead Spike Solution	--	--	--	10.0	10.3	103	--	85 – 115%

Note: *U* - not detected; value represents detection limit.
-- - not applicable
[a] Value from a NIST study of acid-leachable arsenic in this standard reference material (Kane 1995).

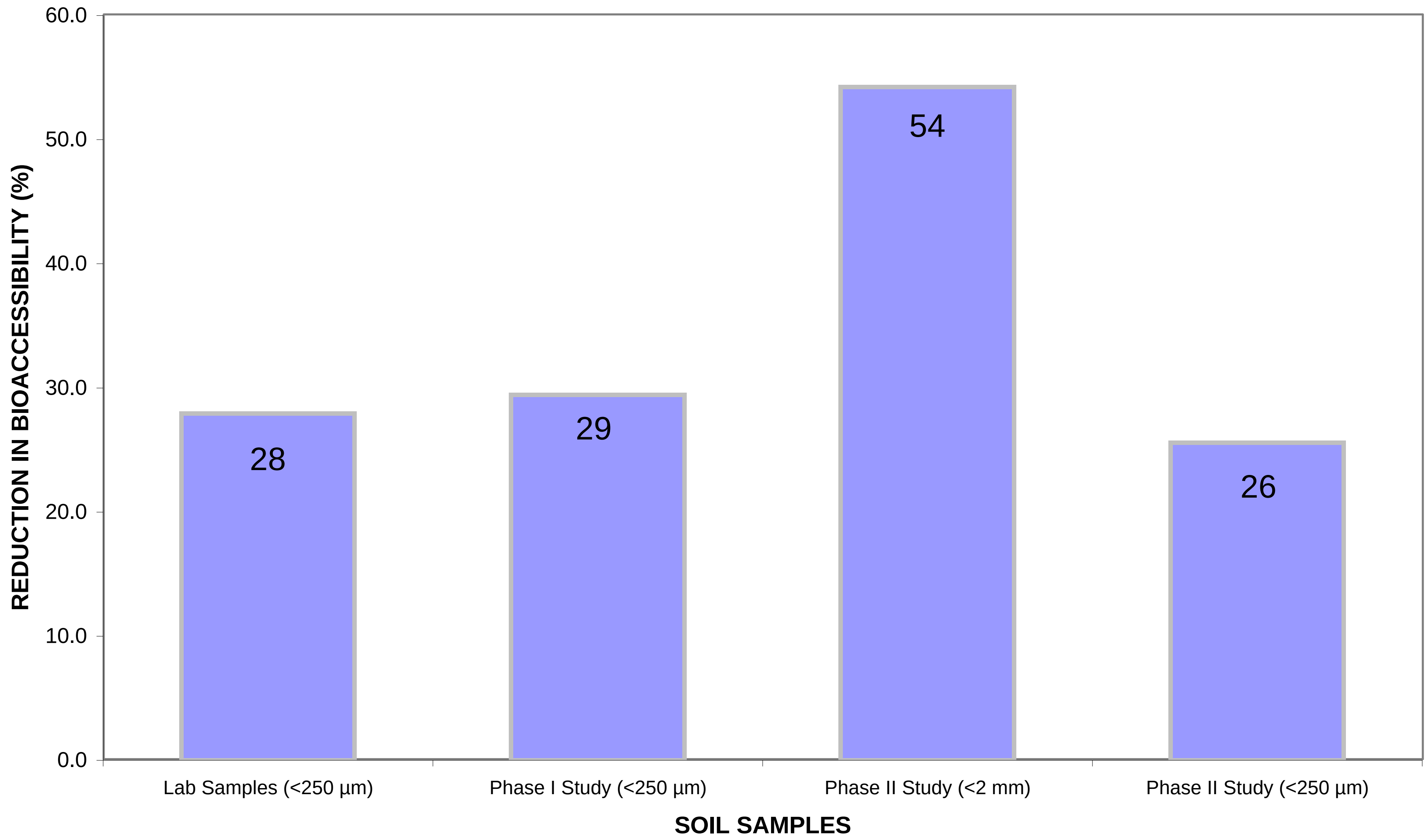


Figure 1. Change in bioaccessibility for amended Camp Stanley soils.

Attachment 1

In Vitro Extraction Procedure

Solubility/Bioavailability Research Consortium

Standard Operating Procedure:

***In Vitro* Method for Determination of Lead and Arsenic Bioaccessibility**

Contents

Introduction

Synopsis

This SOP describes an *in vitro* laboratory procedure to determine a bioaccessibility value for lead or arsenic (i.e., the fraction that would be soluble in the gastrointestinal tract) for soils and solid waste materials. A recommended quality assurance program to be followed when performing this extraction procedure is also provided.

Purpose

An increasingly important property of materials/soils found at contaminated sites is the bioavailability of individual contaminants. Bioavailability is the fraction of a contaminant in a particular environmental matrix that is absorbed by an organism via a specific exposure route. Many animal studies have been conducted to experimentally determine the oral bioavailability of individual metals, particularly lead and arsenic. During the period 1989–1997, a juvenile swine model developed by EPA Region VIII was used to predict the relative bioavailability of lead and arsenic in approximately 20 soils/solid materials (Weis and LaVelle 1991; Weis et al. 1994; Casteel et al. 1997a,b). The bioavailability determined was relative to that of a soluble salt (i.e., lead acetate trihydrate or sodium arsenate). The tested materials had a wide range of mineralogy, and produced a range of lead and arsenic bioavailability values. In addition to the swine studies, other animal models (e.g., rats and monkeys) have been used to measure the bioavailability of lead and arsenic from soil.

Several researchers have developed *in vitro* tests to measure the fraction of a chemical solubilized from a soil sample under simulated gastrointestinal conditions. This measurement is referred to as “bioaccessibility” (Ruby et al. 1993). Bioaccessibility is thought to be an important determinant of bioavailability, and several groups have sought to compare bioaccessibility determined in the laboratory to bioavailability determined in animal studies (Imber 1993; Ruby et al. 1996; Medlin 1997; Rodriguez et al. 1999). The *in vitro* tests consist of an aqueous fluid, into which soils containing lead and arsenic are introduced. The solution then solubilizes the soil under simulated gastric conditions. Once this procedure is complete, the solution is analyzed for lead and/or arsenic concentration. The mass of lead and/or arsenic found in the aqueous phase, as defined by filtration at the 0.45-μm pore size, is compared to the mass introduced into the test. The fraction liberated into the aqueous phase is defined as the bioaccessible fraction of lead or arsenic in that soil. To date, for lead-bearing soils tested in the EPA swine studies, this *in vitro* method has correlated well with relative bioavailability values.

Procedure

Sample Preparation

All soil/material samples should be prepared for testing by oven drying (<40 °C) and sieving to <250 μm. The <250-μm size fraction is used because this particle size is representative of that which adheres to children's hands. Subsamples for testing in this procedure should be obtained using a sample splitter.

Apparatus and Materials

Equipment

The main piece of equipment required for this procedure consists of a Toxicity Characteristic Leaching Procedure (TCLP) extractor motor that has been modified to drive a flywheel. This flywheel in turn drives a Plexiglass block situated inside a temperature-controlled water bath. The Plexiglass block contains ten 5-cm holes with stainless steel screw clamps, each of which is designed to hold a 125-mL wide-mouth high-density polyethylene (HDPE) bottle (see Figure 1). The water bath must be filled such that the extraction bottles are immersed. Temperature in the water bath is maintained at 37±2 °C using an immersion circulator heater (for example, Fisher Scientific Model 730). Additional equipment for this method includes typical laboratory supplies and reagents, as described in the following sections.

The 125-mL HDPE bottles must have an air-tight screw-cap seal (for example, Fisher Scientific 125-mL wide-mouth HDPE Cat. No. 02-893-5C), and care must be taken to ensure that the bottles do not leak during the extraction procedure.

Standards and Reagents

The leaching procedure for this method uses a buffered extraction fluid at a pH of 1.5. The extraction fluid is prepared as described below.

The extraction fluid should be prepared using ASTM Type II deionized (DI) water. To 1.9 L of DI water, add 60.06 g glycine (free base, Sigma Ultra or equivalent). Place the mixture in a water bath at 37 °C until the extraction fluid reaches 37 °C. Standardize the pH meter using temperature compensation at 37 °C or buffers maintained at 37 °C in the water bath. Add concentrated hydrochloric acid (12.1 N, Trace Metal grade) until the solution pH reaches a value of 1.50 ±0.05 (approximately 120 mL). Bring the solution to a final volume of 2 L (0.4 M glycine).

Cleanliness of all reagents and equipment used to prepare and/or store the extraction fluid is essential. All glassware and equipment used to prepare standards and reagents must be properly cleaned, acid washed, and finally, rinsed with DI water prior to use. All reagents must be free of lead and arsenic, and the final fluid should be tested to confirm that lead and arsenic concentrations are less than 25 and 5 μg/L, respectively.

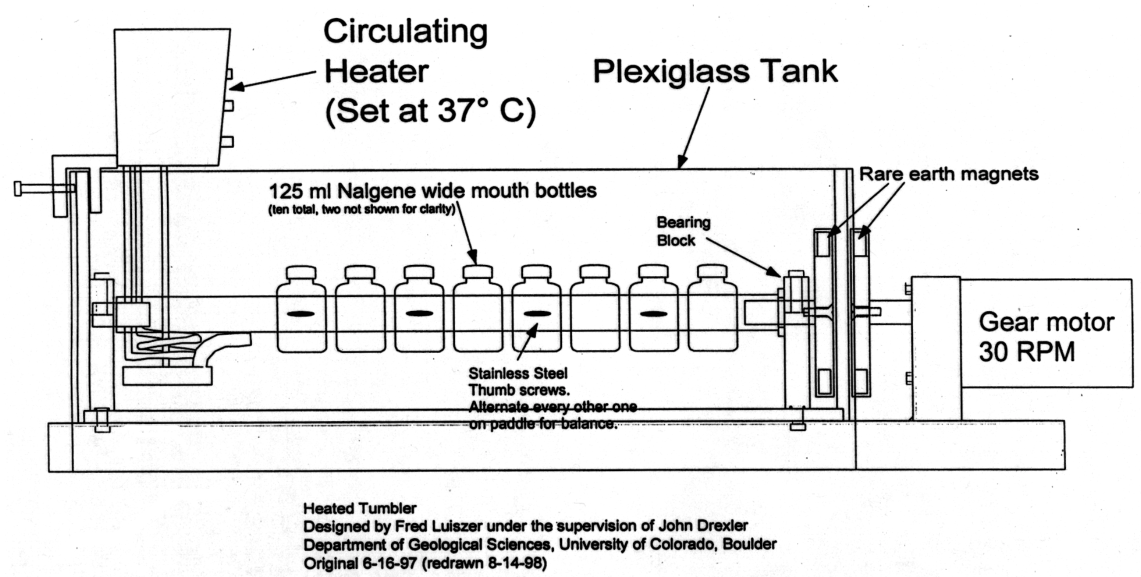


Figure 1. Extraction device for performing the SBRC *in vitro* extraction

Leaching Procedure

Measure 100 ±0.5 mL of the extraction fluid, using a graduated cylinder, and transfer to a 125-mL wide-mouth HDPE bottle. Add 1.00 ±0.05 g of test substrate (<250 μm) to the bottle, ensuring that static electricity does not cause soil particles to adhere to the lip or outside threads of the bottle. If necessary, use an antistatic brush to eliminate static electricity prior to adding the soil. Record the volume of solution and mass of soil added to the bottle on the extraction test checklist (see Attachment A for example checklists). Hand-tighten each bottle top, and shake/invert to ensure that no leakage occurs, and that no soil is caked on the bottom of the bottle.

Place the bottle into the modified TCLP extractor, making sure each bottle is secure and the lid(s) are tightly fastened. Fill the extractor with 125-mL bottles containing test materials or Quality Control samples.

The temperature of the water bath must be 37±2 °C. Record the temperature of the water bath at the beginning and end of each extraction batch on the appropriate extraction test checklist sheet (see Attachment A).

Rotate the extractor end over end at 30±2 rpm for 1 hour. Record start time of rotation.

When extraction (rotation) is complete, immediately remove bottles, wipe them dry, and place them upright on the bench top.

Draw extract directly from reaction vessel into a disposable 20-cc syringe with a Luer-Lok attachment. Attach a 0.45-μm cellulose acetate disk filter (25 mm diameter) to the syringe, and filter the extract into a clean 15-mL polypropylene centrifuge tube or other appropriate sample vial for analysis. Store filtered sample(s) in a refrigerator at 4 °C until they are analyzed.

Record the time that the extract is filtered (i.e., extraction is stopped). If the total elapsed time is greater than 1 hour 30 minutes, the test must be repeated.

Measure and record the pH of fluid remaining in the extraction bottle. If the fluid pH is not within ±0.5 pH units of the starting pH, the test must be discarded and the sample reanalyzed as follows.

If the pH has dropped by 0.5 or more pH units, the test will be re-run in an identical fashion. If the second test also results in a decrease in pH of greater than 0.5 s.u., the pH will be recorded, and the extract filtered for analysis. If the pH has increased by 0.5 or more units, the test must be repeated, but the extractor must be stopped at specific intervals and the pH manually adjusted down to pH 1.5 with dropwise addition of HCl (adjustments at 5, 10, 15, and 30 minutes into the extraction, and upon final removal from the water bath [60 minutes]). Samples with rising pH values must be run in a separate extraction, and must not be combined with samples being extracted by the standard method (continuous extraction).

Extracts are to be analyzed for lead and arsenic concentration using analytical procedures taken from the U.S. EPA publication, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846*. (current revisions). Inductively coupled plasma (ICP) analysis, method 6010B (December 1996 revision) will be the method of choice. This method should be adequate for determination of lead concentrations in sample extracts, at a project-required detection limit (PRDL) of 100 μg/L. The PRDL of 20 μg/L for arsenic may be too low for ICP analysis for some samples. For extracts that have arsenic concentrations less than five times the PRDL (e.g., <100 μg/L arsenic), analysis by ICP-hydride generation (method 7061A, July 1992 revision) or ICP-MS (method 6020, September 1994 revision) will be required.

Calculation of the Bioaccessibility Value

A split of each solid material (<250 μm) that has been subjected to this extraction procedure should be analyzed for total lead and/or arsenic concentration using analytical procedures taken from the U.S. EPA publication, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846*. (current revisions). The solid material should be acid digested according to method 3050A (July 1992 revision) or method 3051 (microwave-assisted digestion, September 1994 revision), and the digestate analyzed for lead and/or arsenic concentration by ICP analysis (method 6010B). For samples that

have arsenic concentrations below ICP detection limits, analysis by ICP-hydride generation (method 7061A, July 1992 revision) or ICP-MS (method 6020, September 1994 revision) will be required.

The bioaccessibility of lead or arsenic is calculated in the following manner:

$$\textit{Bioaccessibility value} = \frac{\textit{(concentration in in vitro extract, mg/L)}\ (0.1L)}{\textit{(concentration in solid, mg/kg)}\ (\ 0.001\ \textit{kg)}} \times 100$$

Chain-of-Custody/Good Laboratory Practices

All laboratories that use this SOP should receive test materials with chain-of-custody documentation. When materials are received, each laboratory will maintain and record custody of samples at all times. All laboratories that perform this procedure should follow good laboratory practices as defined in 40 CFR Part 792 to the extent practical and possible.

Data Handling and Verification

All sample and fluid preparation calculations and operations should be recorded in bound and numbered laboratory notebooks, and on extraction test checklist sheets. Each page must be dated and initialed by the person who performs any operations. Extraction and filtration times must be recorded, along with pH measurements, adjustments, and buffer preparation. Copies of the extraction test checklist sheets should accompany the data package.

Quality Control Procedures

Elements of Quality Assurance and Quality Control (QA/QC)

A standard method for the *in vitro* extraction of soils/solid materials, and the calculation of an associated bioaccessibility value, are specified above. Associated QC procedures to ensure production of high-quality data are as follows (see Table 1 for summary of QC procedures, frequency, and control limits):

- Reagent blank—Extraction fluid analyzed once per batch.
- Bottle blank—Extraction fluid only run through the complete extraction procedure at a frequency of no less than 1 per 20 samples or one per extraction batch, whichever is more frequent.
- Blank spikes—Extraction fluid spiked at 10 mg/L lead and/or 1 mg/L arsenic and run through the extraction procedure at a frequency of no less than every 20 samples or one per extraction batch, whichever is more frequent. Blank spikes should be prepared using traceable 1,000-mg/L lead and arsenic standards in 2 percent nitric acid.
- Duplicate—duplicate extractions are required at a frequency of 1 for every 10 samples. At least one duplicate must be performed on each day that extractions are conducted.
- Standard Reference Material (SRM)—National Institute of Standards and Technology (NIST) material 2711 (Montana Soil) should be used as a laboratory control sample (LCS).

Control limits for these QC samples are delineated in Table 1, and in the following discussion.

Table 1. Summary of QC samples, frequency of analysis, and control limits

QC Sample	Minimum Frequency of Analysis	Control Limits
Reagent Blank	Once per batch (min. 5%)	<25 μg/L lead <5 μg/L arsenic
Bottle Blank	Once per batch (min. 5%)	<50 μg/L lead <10 μg/L arsenic
Blank Spike	Once per batch (min. 5%)	85–115% recovery
Duplicate	10%	±20% RPD
SRM (NIST 2711)	2%	9.22 ±1.50 mg/L Pb 0.59 ±0.09 mg/L As

QA/QC Procedures

Specific laboratory procedures and QC steps are described in the analytical methods cited in Section 2.3, and should be followed when using this SOP.

Laboratory Control Sample (LCS)

The NIST SRM 2711 should be used as a laboratory control sample for the *in vitro* extraction procedure. Analysis of 18 blind splits of NIST SRM 2711 (105 mg/kg arsenic and 1,162 mg/kg lead) in four independent laboratories resulted in arithmetic means ± standard deviations of 9.22 ±1.50 mg/L lead and 0.59 ±0.09 mg/L arsenic. This SRM is available from the National Institute of Standards and Technology, Standard Reference Materials Program, Room 204, Building 202, Gaithersburg, Maryland 20899 (301/975-6776).

Reagent Blanks/Bottle Blanks/Blank Spikes

Reagent blanks must not contain more than 5 μg/L arsenic or 25 μg/L lead. Bottle blanks must not contain arsenic and/or lead concentrations greater than 10 and 50 μg/L, respectively. If either the reagent blank or a bottle blank exceeds these values, contamination of reagents, water, or equipment should be suspected. In this case, the laboratory must investigate possible sources of contamination and mitigate the problem before continuing with sample analysis. Blank spikes should be within 15% of their true value. If recovery of any blank spike is outside this range, possible errors in preparation, contamination, or instrument problems should be suspected. In the case of a blank spike outside specified limits, the problems must be investigated and corrected before continuing sample analysis.

References

Casteel, S.W., R.P. Cowart, C.P. Weis, G.M. Henningsen, E. Hoffman, et al. 1997a. Bioavailability of lead in soil from the Smuggler Mountain site of Aspen, Colorado. Fund. Appl. Toxicol. 36:177–187.

Casteel, S.W., L.D. Brown, M.E. Dunsmore, C.P. Weis, G.M.Henningsen, E. Hoffman, W.J. Brattin, and T.L. Hammon. 1997b. Relative bioavailability of arsenic in mining waste. U.S. Environmental Protection Agency, Region VIII, Denver, CO.

Imber, B.D. 1993. Development of a physiologically relevant extraction procedure. Prepared for BC Ministry of Environment, Lands and Parks, Environmental Protection Division, Victoria, BC. CB Research International Corporation, Sidney, BC.

Medlin, E.A. 1997. An *in vitro* method for estimating the relative bioavailability of lead in humans. Masters thesis. Department of Geological Sciences, University of Colorado, Boulder.

Rodriguez, R.R., N.T. Basta, S.W. Casteel, and L.W. Pace. 1999. An in vitro gastrointestinal method to estimate bioavailable arsenic in contaminated soils and solid media. Environ. Sci. Technol. 33(4):642–649.

Ruby, M.W., A. Davis, T.E. Link, R. Schoof, R.L. Chaney, G.B. Freeman, and P. Bergstrom. 1993. Development of an *in vitro* screening test to evaluate the *in vivo* bioaccessibility of ingested mine-waste lead. Environ. Sci. Technol. 27(13):2870–2877.

Ruby, M.W., A. Davis, R. Schoof, S. Eberle, and C.M. Sellstone. 1996. Estimation of lead and arsenic bioavailability using a physiologically based extraction test. Environ. Sci. Technol. 30(2):422–430.

Weis, C.P., and J.M. LaVelle. 1991. Characteristics to consider when choosing an animal model for the study of lead bioavailability. In: Proceedings of the International Symposium on the Bioavailability and Dietary Uptake of Lead. Sci. Technol. Let. 3:113–119.

Weis, C.P., R.H. Poppenga, B.J. Thacker, and G.M. Henningsen. 1994. Design of phamacokinetic and bioavailability studies of lead in an immature swine model. In: Lead in paint, soil, and dust: Health risks, exposure studies, control measures, measurement methods, and quality assurance, ASTM STP 1226, M.E. Beard and S.A. Iske (Eds.). American Society for Testing and Materials, Philadelphia, PA, 19103-1187.

Attachment A:

Extraction Test Checklist Sheets

Extraction Fluid Preparation

Date of Extraction Fluid Preparation:____________ Prepared by:_____________
Extraction Fluid Lot #:________________________

Component	Lot Number	Fluid Preparation 1L	Fluid Preparation 2L	Acceptance Range	Actual Quantity	Comments
Deionized Water		0.95 L (approx.)	1.9 L (approx.)	---		
Glycine		30.03±0.05 g	60.06±0.05g	---		
HCl [a]		60 mL (approx.)	120 mL (approx.)	---		
Final Volume	---	1 L (Class A, vol.)	2 L (Class A, vol.)	---		
Extraction Fluid pH value (@ 37°C)	---	1.50±0.05	1.50±0.05	1.45–1.55		

[a] Concentrated hydrochloric acid (12.1 N)

Required Parameters:

Volume of extraction fluid (V) = 100 ±0.5 mL
Mass of test substrate (M) = 1.00 ±0.05 g
Temperature of water bath = 37 ±2 °C
Extraction time = 60 ±5 min

Extractor rotation speed = 30 ±2 rpm
Maximum elapsed time from extraction to filtration = 90 minutes
Maximum pH difference from start to finish (ΔpH)= 0.5 pH units
Spike solution concentrations: As = 1 mg/L; Pb = 10 mg/L

Date of Extraction:___________________________
Extraction Fluid Lot #:_________________________
Extracted by:_________________________________

As Spike Solution Lot #:__________________________________
Pb Spike Solution Lot #:__________________________________

Extraction Log:

Sample ID	Sample Preparation		Extraction								Filtration	
	V (mL)	M (g)	Start Time[a]	End Time[a]	Elapsed Time (min)	Start pH	End pH	ΔpH	Start Temp (°C)	End Temp (°C)	Time[a]	Time Elasped from extraction (min)
Acceptance Range	(95.5–100.5)	(0.95–1.05)	---	---	(55–65 min)	---	---	(Max = 0.5)	(35–39)	(35–39)		(Max = 90 min)
Bottle Blank												
Duplicate												
Matrix spike												

[a] 24-hour time scale

Analytical Procedures

QC Requirements:

QC Sample	Minimum Analysis Frequency	Control Limits	Corrective Action[a]
Reagent blank	once per batch (min. 5%)	< 25 µg/L Pb <5 µg/L As	Investigate possible sources of target analytes. Mitigate contamination problem before continuing analysis.
Bottle blank	once per batch (min. 5%)	< 50 µg/L Pb <10 µg/L As	Investigate possible sources of target analytes. Mitigate contamination problem before continuing analysis.
Blank spike	once per batch (min. 5%)	85–115%	Re-extract and reanalyze sample batch
Duplicate	10% (min. once/day)	±20% RPD	Re-homongenize, re-extract and reanalyze

RPD – Relative percent difference
a – Action required if control limits are not met

Appendix E
Quality Assurance Project Plan

HQ Air Force Center for Environmental Excellence

QUALITY ASSURANCE PROJECT PLAN

Version 3.0

March 1998

PREFACE

This document is the *Air Force Center for Environmental Excellence Quality Assurance Project Plan (QAPP), version 3.0.* This detailed QAPP, (1) has been prepared for use by contractors who perform environmental services to ensure the data are scientifically valid and defensible, and (2) establishes the analytical protocols and documentation requirements to ensure the data are collected, reviewed, and analyzed in a consistent manner. This QAPP and a site specific Field Sampling Plan (FSP) shall constitute, by definition, an AFCEE Sampling and Analysis Plan (SAP). All prime contractors and laboratories performing work in support of AFCEE contracts shall perform their services in accordance with the requirements specified in this QAPP. A variance shall be requested for any exception to or deviation from the requirements in this QAPP. Variance requests are submitted as an addendum to the SAP. Variances from the QAPP shall be identified by chapter, subtitle, paragraph, page, and line with supporting justification for the change. The original text in this QAPP is crossed out and a reference to the appropriate variance request by number in the addendum is added to the QAPP. If any additional analytical methods are required in the SAP that are not in this QAPP, the analytical methods must be included in the addendum to the SAP with all the accompanying quality control requirements, i.e., reporting limits, calibration requirements, quality control measures, corrective action, data validation, and reporting requirements, comparable in format to the analytical tables in Sections 6, 7, and 8. Variances must be approved by the AFCEE Team Chief for the project. Only the variances approved by the AFCEE Team Chief shall be included in the final version of the SAP.

LIST OF ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AFCEE	Air Force Center for Environmental Excellence
AFIID	Air Force installation identification
A2LA	American Association for Laboratory Accreditation
ARAR	applicable or relevant and appropriate requirement
ASCII	American Standard Code Information Interchange
ASTM	American Society for Testing and Materials
BFB	bromofluorobenzene
Br^-	bromide
BTEX	benzene, toluene, ethylbenzene, xylene
°C	degrees Celsius
CCC	calibration check compound
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CF	calibration factor
CFR	Code of Federal Regulation
Cl^-	chloride
CL	control limit
CLP	Contract Laboratory Program
COC	chain of custody
2,4-D	2,4-dichlorophenoxy propanoic acid
2,4-DB	2,4-dichlorophenoxy butyric acid
DCA	dichloroethane
DCB	dichlorobenzene
DCBP	decachlorobiphenyl
DCE	dichloroethene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethene
DDT	dichlorodiphenyltrichloroethane
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DFTPP	decafluorotriphenylphosphine
DNB	dinitrobenzene
DNT	dinitrotoluene

DOD	Department of Defense
DQO	data quality objective
DRO	diesel range organics
EDB	ethylene dibromide
EICP	extracted ion current profile
EPA	Environmental Protection Agency
ERPIMS	Environmental Resources Program Information Management System
F^-	fluoride
FID	flame ionization detector
FLAA	flame atomic absorption
FS	feasibility study
FSP	field sampling plan
g	gram
G	glass
GC	gas chromatography
GC/MS	gas chromatography/mass spectroscopy
GFAA	graphite furnace atomic absorption
GRO	gasoline range organics
Handbook	*Handbook for the Installation Restoration Program (IRP) Remedial Investigation and Feasibility Studies (RI/FS)*, September 1993
HCl	hydrochloric acid
HECD	(Hall) electrolytic conductivity detector
HpCDD	heptachlorodibenzo-p-dioxin
HpCDF	heptaclorordibenzofuran
HxCDD	hexachlorodibenzo-p-dioxin
HxCDF	hexachlorodibenzofuran
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HNO_3	nitric acid
HPLC	high-performance liquid chromatography
H_2SO_4	sulfuric acid
IAW	in accordance with
ICP	inductively coupled plasma
ICPES	inductively coupled plasma emission spectroscopy
ICP-MS	inductively coupled plasma - mass spectroscopy
ICS	interference check standard

ID	identification
IRP	Installation Restoration Program
IS	internal standard
LCL	lower control limit
LCS	laboratory control sample
MCPA	(4-chloro-2-methylphenoxy) acetic acid
MCPP	2-(4-chloro-2-methylphenoxy) propionic acid
MDL	method detection limit
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mL	milliliter
mm	millimeter
MS	matrix spike
MSD	matrix spike duplicate
N/A	not applicable
$Na_2S_2O_3$	sodium thiosulfate
NCP	National Contingency Plan
ng/L	nanograms per liter
ng/mL	nanograms per milliliter
NIST	National Institute of Standards and Technology
nm	nanometer
NO_2^-	nitrite
NO_3^-	nitrate
NTU	nephelometric turbidity unit
OCDD	octachlorodibenzo-p-dioxin
ORP	oxidation-reduction potential
OVA	organic vapor analyzer
P	polyethylene
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCDD	polychlorinated dibenzo-p-dioxin
PCDF	polychlorinated dibenzofuran
PE	performance evaluation
PeCDD	pentachlorodibenzo-p-dioxin
PeCDF	pentachlorodibenzofuran

PID	photoionization detector
PO_4^{-3}	phosphate
ppb	parts per billion
ppm	parts per million
ppmv	parts per million volume
PQL	practical quantitation limit
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
R	recovery
RCA	recommendations for corrective action
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RF	response factor
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RPD	relative percent difference
RSD	relative standard deviation
S	soil
SAP	sampling and analysis plan
SARA	Superfund Amendments and Reauthorization Act
SO_4^{-2}	sulfate
SOP	standard operating procedure
SOW	statement of work
SPCC	system performance check compound
SVOC	semivolatile organic compound
2,4,5-T	2,4,5-trichlorophenoxy acetic acid
T	California brass
TCA	trichloroethane
TCDD	tetrachlorodibenzo-p-dioxin
TCDF	tetrachlorodibenzofuran
TCE	trichloroethene
TCLP	toxicity characteristic leaching procedure
TCMX	tetrachlorometaxylene
TIC	tentatively identified compound
TNB	trinitrobenzene

TNT	trinitrotoluene
2,4,5-TP	2,4,5-trichlorophenoxy propanoic acid (silvex)
TPH	total petroleum hydrocarbon
UCL	upper control limit
VOC	volatile organic compound
v/v	volume to volume
W	water

SYMBOLS

μg/kg	micrograms per kilogram
μg/L	micrograms per liter
μg/mL	micrograms per milliliter
μL	microliter
μm	micrometer

This page intentionally left blank.

TABLE OF CONTENTS

SECTION **PAGE**

SECTION **PAGE**

SECTION **PAGE**

SECTION **PAGE**

LIST OF TABLES

TABLE **PAGE**

1.0 INTRODUCTION

The Quality Assurance Project Plan (QAPP) presents in specific terms the policies, organization, functions, and Quality Assurance/Quality Control (QA/QC) requirements designed to achieve the data quality goals described in the approved Sampling and Analysis Plan (SAP) for the project. This detailed QAPP, (1) has been prepared for use by contractors who perform environmental services to ensure the data are scientifically valid and defensible, and (2) establishes the analytical protocols and documentation requirements to ensure the data are collected, reviewed, and analyzed in a consistent manner. This QAPP and a site specific Field Sampling Plan (FSP) shall constitute, by definition, an AFCEE Sampling and Analysis Plan (SAP).

The National Contingency Plan (NCP) specifies circumstances under which a QAPP is necessary for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions. For cleanup actions at the remedial investigation/feasibility study (RI/FS) stage, the NCP requires lead agents to develop sampling and analysis plans which provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. Such sampling and analysis plans must include a quality assurance project plan "which describes policy, organization, and functional activities and the data quality objectives and measures necessary to achieve adequate data for use in selecting the appropriate remedy." 40 CFR 300.430 (b)(8)(ii).

The U.S. Environmental Protection Agency (EPA) QA policy requires a QAPP for every monitoring and measurement project mandated or supported by the EPA through regulations, contracts, or other formalized means not currently covered by regulation. Guidelines followed in the preparation of this plan are set out in *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (U.S. EPA, 1983a) and *U.S. EPA Region IX QAPP: Guidance for Preparing QAPPs for Superfund Remedial Projects* (U.S. EPA, 1989). Other documents that have been referenced for this plan include *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (U.S. EPA, 1988); *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Final, EPA QA/R-5* (U.S. EPA, 1993), *Compendium of Superfund Field Operations Methods* (U.S. EPA, 1987a); *Data Quality Objectives Process for Superfund, Interim Final Guidance* (U.S. EPA, 1993); *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (U.S. EPA, 1994), *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (U.S. EPA, 1994), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition and its first, second and third update), and the *Handbook for Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)* (Handbook), September 1993.

This QAPP is required reading for all staff participating in the work effort. The QAPP shall be in the possession of the field teams and in the laboratories performing all analytical methods. All contractors and subcontractors shall be required to comply with the procedures documented in this QAPP in order to maintain comparability and representativeness of the data produced.

Controlled distribution of the QAPP shall be implemented by the prime contractor to ensure the current version is being used. A sequential numbering system shall be used to identify controlled copies of the QAPP. Controlled copies shall be provided to applicable Air Force managers, regulatory agencies, remedial project managers, project managers, and QA coordinators. Whenever Air Force revisions are made or addenda added to the QAPP, a document control system shall be put into place to assure (1) all parties holding a controlled copy of the QAPP shall receive the revisions/addenda and (2) outdated material is removed from circulation. The document control system does not preclude making and using copies of the QAPP; however, the holders of controlled copies are responsible for distributing additional material to update any copies within their organizations. The distribution list for controlled copies shall be maintained by the prime contractor.

2.0 PROJECT DESCRIPTION

2.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force Installation Restoration Project (IRP) is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations and to develop remedial actions consistent with the NCP for sites that pose a threat to human health and welfare or the environment. This section presents information on the program origins, objectives, and organization.

The 1976 Resource Conservation Recovery Act (RCRA) is one of the primary federal laws governing the disposal of hazardous wastes. Sections 6001 and 6003 of RCRA require federal agencies to comply with local and state environmental regulations and provide information to the EPA concerning past disposal practices at federal sites. RCRA Section 3012 requires state agencies to inventory past hazardous waste disposal sites and provide information to the EPA concerning those sites.

In 1980, Congress enacted CERCLA (Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

The 1986 Superfund Amendments and Reauthorization Act (SARA) extends the requirements of CERCLA and modifies CERCLA with respect to goals for remediation and the steps that lead to the selection of a remedial process. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to action that only contains or isolates the contaminant. SARA also provides for greater interaction with public and state agencies and extends the EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and the consideration of potential remediation alternatives is recommended at the initiation of an RI/FS. SARA is the primary legislation governing remedial action at past hazardous waste disposal sites.

Executive Order 12580, adopted in 1987, gave various federal agencies, including the Department of Defense (DOD), the responsibility to act as lead agencies for conducting investigations and implementing remediation efforts when they are the sole or co-contributor to contamination on or off their properties.

To ensure compliance with CERCLA, its regulations, and Executive Order 12580, the DOD developed the IRP, under the Defense Environmental Restoration Program, to identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially contaminated facilities. The DOD issued the Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6 regarding the IRP program in June 1980, and

implemented the policies outlined in this memorandum in December 1980. The NCP was issued by EPA in 1980 to provide guidance on a process by which (1) contaminant release could be reported, (2) contamination could be identified and quantified, and (3) remedial actions could be selected. The NCP describes the responsibility of federal and state governments and those responsible for contaminant releases.

The DOD formally revised and expanded the existing IRP directives and amplified all previous directives and memoranda concerning the IRP through DEQPPM 81-5, dated 11 December 1981. The memorandum was implemented by a U.S. Air Force message dated 21 January 1982.

The IRP is the DOD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for an RI/FS program. The IRP was modified so that RI/FS studies could be conducted as parallel activities rather than serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed and modified to ensure that DOD compliance with federal laws, such as RCRA, NCP, CERCLA, and SARA, can be met.

2.2 PURPOSE AND SCOPE

The purpose, scope, and use of this work effort shall be briefly discussed in Section 2.2 of the FSP.

2.3 PROJECT BACKGROUND

A project background description, including (1) the locations of sites at the base or facility, (2) a summary of the contamination history at each site and (3) the findings from previous investigations shall be included in Section 2.3 and Section 2.4 of the FSP.

2.4 PROJECT SCOPE AND OBJECTIVES

A summary of the objectives and the proposed work for each site shall be included in Section 3.1, Section 3.2 and Section 3.3 of the FSP. The intended use of the data acquired during this project, the data quality objective process and a discussion of how the process specific decision rules were derived shall also be described in Section 3.1 of the FSP.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization and responsibility discussion including (1) a project organizational chart identifying task managers and individuals responsible for performance of the project, (2) a list of names of all key participants, including organization names and telephone numbers for project, field, and laboratory QA officers, (3) a description of the authority given to each key participant with an emphasis on the authority of the key individuals to initiate and approve corrective actions, and (4) the role of regulatory representatives shall be included in Section 4.0 of the FSP.

All contractors and subcontractors shall be identified and the scope of their performance in the project shall be clearly defined. Subcontractors proposed to provide backup services shall be identified. An organizational chart, a list of key personnel, and the previously described descriptive text shall be included for each subcontractor in Section 4.1 of the FSP.

This page intentionally left blank.

4.0 QUALITY PROGRAM AND DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) specify the data type, quality, quantity, and uses needed to make decisions and are the basis for designing data collection activities. The DQOs for the project are specified in the FSP in Section 3.1.

4.1 DATA CATEGORIES

The two general categories of data used by the Air Force Center for Environmental Excellence (AFCEE) are defined as: (1) screening data and (2) definitive data.

Screening data are generated by rapid methods of analysis with less rigorous sample preparation, calibration and/or QC requirements than are necessary to produce definitive data. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data may provide analyte identification and quantitation, although the quantitation may be relatively imprecise. Physical test methods, e.g., dissolved oxygen measurements, temperature and pH measurements, moisture content, turbidity, conductance, etc., have been designated by definition as screening methods (see Section 6).

Screening methods shall be confirmed, as required in Section 3.2 of the FSP, by analyses that generate definitive data. Confirmation samples shall be selected to include both detected and nondetected results from the screening method.

Definitive data are generated using rigorous analytical methods (see Section 7), such as approved EPA reference methods. The data can be generated in a mobile or off-site laboratory. Data are analyte-specific, and both identification and quantitation are confirmed. These methods have standardized QC and documentation requirements (Sections 7 and 8). Definitive data are not restricted in their use unless quality problems require data qualification.

4.2 PRECISION, ACCURACY, REPRESENTATIVENESS, COMPLETENESS, AND COMPARABILITY

The basis for assessing each of these elements of data quality is discussed in the following subsections. Precision and accuracy QC limits for each method and matrix are identified in Sections 6 and 7.

4.2.1 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. *Analytical* precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. AFCEE uses the laboratory control sample (LCS) to determine the precision of the analytical method. If the recoveries of analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch, rather the comparison is between the sample and samples analyzed in previous batches. *Total* precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. The formula for the calculation of precision is provided in Table 4.2.1-1 as RPD. For replicate analyses, the relative standard deviation (RSD) is determined. The formula for the calculation of RSD is provided in Table 4.2.1-1.

4.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It therefore reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples shall also be used to provide additional information for assessing the accuracy of the analytical data being produced.

Both accuracy and precision are calculated for each AFCEE analytical batch, and the associated sample results are interpreted by considering these specific measurements. The formula for calculation of accuracy is included in Table 4.2.1-1 as percent recovery (%R) from pure and sample matrices.

4.2.3 Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design, with consideration of elements such as proper well locations, drilling and installation procedures, and sampling locations. Decisions regarding sample/well/boring locations and numbers and the statistical sampling design are documented in Section 3.3 of the FSP.

4.2.4 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an "R" flag (see Section 8 for an explanation of flagging criteria). The requirement for completeness is 95 percent for aqueous samples and 90 percent for soil samples. For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculation of completeness is presented below:

$$\%\ \text{completeness} = \frac{\text{number of valid (i.e., non-R flagged) results}}{\text{number of possible results}}$$

4.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using

standard methods for sampling and analysis, reporting data in standard units, normalizing results to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Analysis of performance evaluation (PE) samples and reports from audits shall also be used to provide additional information for assessing the comparability of analytical data produced among subcontracting laboratories. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

Table 4.2.1-1 Statistical Calculations

Statistic	Symbol	Formula	Definition	Uses
Mean	$\overline{X}$	$\dfrac{\left(\sum_{i=1}^{n} x_i\right)}{n}$	Measure of central tendency	Used to determine average value of measurements
Standard Deviation	S	$\left(\dfrac{\Sigma(x_i-\overline{x})^2}{(n-1)}\right)^{½}$	Measure of relative scatter of the data	Used in calculating variation of measurements
Relative Standard Deviation	RSD	$(S/\overline{X}) \times 100$	Relative standard deviation, adjusts for magnitude of observations	Used to assess precision for replicate results
Percent Difference	%D	$\dfrac{x_1 - x_2}{x_1} \times 100$	Measure of the difference of 2 observations	Used to assess accuracy
Relative Percent Difference	RPD	$\left(\dfrac{(X_1 - X_2)}{(X_1 + X_2)/2}\right) \times 100$	Measure of variability that adjusts for the magnitude of observations	Used to assess total and analytical precision of duplicate measurements
Percent Recovery	%R	$\left(\dfrac{X_{meas}}{X_{true}}\right) \times 100$	Recovery of spiked compound in pure matrix	Used to assess accuracy
Percent Recovery	%R	$\dfrac{\left(\text{value of spiked sample} - \text{value of unspiked sample}\right)}{\text{Value of added spike}} \times 100$	Recovery of spiked compound in sample matrix	Used to assess matrix effects and total precision
Correlation Coefficient	r	see SW8000B section 7.5.3		Evaluation of “goodness of fit” of a regression line
Coefficient of Determination	COD	see SW8000B section 7.5.3		Evaluation of “goodness of fit” of a polynomial equation

x = Observation (concentration)
n = Number of observations

4.3 METHOD DETECTION LIMITS, AFCEE REPORTING LIMITS, AND INSTRUMENT CALIBRATION REQUIREMENTS

4.3.1 Method Detection Limits

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. The laboratory shall establish MDLs for each method, matrix, and analyte for each instrument the laboratory plans to use for the project. The laboratory shall revalidate these MDLs at least once per twelve month period. The laboratory shall provide the MDL demonstrations to AFCEE at the beginning of the project (i.e., before project samples are analyzed) and upon request in the format specified in Section 8. Results less than or equal to the MDL shall be reported as the MDL value and flagged with a "U" (see Section 8).

Laboratories participating in this work effort shall demonstrate the MDLs for each instrument, including confirmatory columns, method of analysis, analyte, and matrix (i.e., water and soil) using the following instructions:

(1) Estimate the MDL using one of the following:

a) the concentration value that corresponds to an instrument signal/noise ratio in the range of 2.5 to 5, or

b) the concentration equivalent of 3 times the standard deviation of replicate measurement of the analyte in reagent water, or

c) the region of the standard curve where there is a significant change in sensitivity (i.e., a break in the slope of the standard curve).

(2) Prepare (i.e., extract, digest, etc.) and analyze seven samples of a matrix spike (ASTM Type II water for aqueous methods, Ottawa sand for soil methods, glass beads of 1 mm diameter or smaller for metals) containing the analyte of interest at a concentration three to five times the estimated MDL.

(3) Determine the variance (S^2) for each analyte as follows:

$$S^2 = \frac{1}{n-1}\left[\sum_{i=1}^{n}\left(x_i - \bar{x}\right)^2\right]$$

where x_i = the ith measurement of the variable x and $\bar{x}$ = the average value of x

$$\overline{X} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

(4) Determine the standard deviation (s) for each analyte as follows:

$$s = (S^2)^{1/2}$$

(5) Determine the MDL for each analyte as follows:

$$MDL = 3.14(s)$$

(note: 3.14 is the one-sided t-statistic at the 99 percent confidence level appropriate for determining the MDL using 7 samples)
(6) If the spike level used in step 2 is more than 5 times the calculated MDL, repeat the process using a smaller spiking level.

Where multiple instruments are used, the MDL used for reporting purposes shall represent the least sensitive instrument.

4.3.2 Reporting Limits

The laboratories participating in this work effort shall compare the results of the MDL demonstrations to the reporting limits (RLs) for each method that is listed in Section 7. The MDL may not be more than one-half the corresponding RL. The laboratories shall also verify RLs by including a standard at or below the RL as the lowest point on the calibration curve. All results shall be reported at or above the MDL values, however, for those results falling between the MDL and the RL, an “F” flag shall be applied to the results indicating the variability associated with the result (see Section 8.0). No results shall be reported below the MDL.

4.3.3 Instrument Calibration

Analytical instruments shall be calibrated in accordance with the analytical methods. All analytes reported shall be present in the initial and continuing calibrations, and these calibrations shall meet the acceptance criteria specified in Section 7. All results reported shall be within the calibration range. Records of standard preparation and instrument calibration shall be maintained. Records shall unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Calibration standards shall be traceable to standard materials.

Instrument calibration shall be checked using all of the analytes listed in the QC acceptance criteria table in Section 7 for the method. This applies equally to multiresponse analytes (except as noted in Section 7). All calibration criteria shall satisfy SW-846 requirements at a minimum. The initial calibration shall be checked at the frequency specified in the method using materials prepared independently of the calibration standards. Multipoint calibrations shall contain the

minimum number of calibration points specified in the method with all points used for the calibration being contiguous. If more than the minimum number of standards is analyzed for the initial calibration, all of the standards analyzed shall be included in the initial calibration. The only exception to this rule is a standard that has been statistically determined as being an outlier can be dropped from the calibration, providing the requirement for the minimum number of standards is met. Acceptance criteria for the calibration check are presented in Section 7. Analyte concentrations are determined with either calibration curves or response factors (RFs). For gas chromatography (GC) and gas chromatography/mass spectroscopy (GC/MS) methods, when using RFs to determine analyte concentrations, the average RF from the initial five point calibration shall be used. The continuing calibration shall not be used to update the RFs from the initial five point calibration. The continuing calibration verification cannot be used as the laboratory control sample (LCS).

4.4 ELEMENTS OF QUALITY CONTROL

QC elements relevant to screening data are presented in Section 6.0. This section presents QC requirements relevant to analysis of environmental samples that shall be followed during all analytical activities for fixed-base, mobile, and field laboratories producing definitive data. The purpose of this QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC materials.

Laboratory QC samples (e.g., blanks and laboratory control samples) shall be included in the preparation batch with the field samples. An AFCEE analytical batch is a number of samples (not to exceed 20 environmental samples plus the associated laboratory QC samples) that are similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. Matrix spikes and matrix spike duplicates count as environmental samples. The term AFCEE analytical batch also extends to cover samples that do not need separate extraction or digestion (e.g., volatile analyses by purge and trap). This AFCEE analytical batch is a number of samples (not to exceed 20 environmental samples plus the associated laboratory QC samples) that are similar in composition (matrix) and analyzed sequentially. The identity of each AFCEE analytical batch shall be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples. All references to the analytical batch in the following sections and tables in this QAPP refer to the AFCEE analytical batch.

The type of QC samples and the frequency of use of these samples are discussed below and in the method-specific subsections of Section 7.

4.4.1 Laboratory Control Sample

The laboratory control sample (LCS) is analyte-free water for aqueous analyses or Ottawa sand for soil analyses (except metals where glass beads of 1mm diameter or smaller may be used) spiked with all analytes listed in the QC acceptance criteria table in Section 7 for the method. Each analyte in the LCS shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. The LCS shall be carried through the complete sample preparation and analysis procedure.

The LCS is used to evaluate each AFCEE analytical batch and to determine if the method is in control. The LCS cannot be used as the continuing calibration verification.

One LCS shall be included in every AFCEE analytical batch. If more than one LCS is analyzed in an AFCEE analytical batch, results from all LCSs analyzed shall be reported. A QC failure of an analyte in any of the LCSs shall require appropriate corrective action including qualification of the failed analyte in all of the samples as required.

The performance of the LCS is evaluated against the QC acceptance limits given in the tables in Section 7.

Whenever an analyte in an LCS is outside the acceptance limit, corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, all samples in the AFCEE analytical batch shall be reanalyzed for the out-of-control analyte(s). When an analyte in an LCS exceeds the upper or lower control limit and no corrective action is performed or the corrective action was ineffective, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to all affected results.

4.4.2 Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) and matrix spike duplicate (MSD) is an aliquot of sample spiked with known concentrations of all analytes listed in the QC acceptance criteria table in Section 7 for the method. The spiking occurs prior to sample preparation and analysis. Each analyte in the MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte. Only AFCEE samples shall be used for spiking. The MS/MSD shall be designated on the chain of custody.

The MS/MSD is used to document the bias of a method due to sample matrix. AFCEE does not use MSs and MSDs to control the analytical process.

A minimum of one MS and one MSD sample shall be analyzed for every 20 AFCEE samples.

The performance of the MS and MSD is evaluated against the QC acceptance limits given in the tables in Section 7. If either the MS or the MSD is outside the QC acceptance limits, the analytes in all related samples shall be qualified according to the data flagging criteria in Sections 7 and 8.

4.4.3 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but that are not normally found in environmental samples.

Surrogates are used to evaluate accuracy, method performance, and extraction efficiency.

Surrogates shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

Whenever a surrogate recovery is outside the acceptance limit, corrective action must be performed. After the system problems have been resolved and system control has been reestablished, reprep and reanalyze the sample. If corrective actions are not performed or are ineffective, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to the sample results.

4.4.4 Internal Standards

Internal standards (ISs) are measured amounts of certain compounds added after preparation or extraction of a sample.

They are used in an IS calibration method to correct sample results affected by column injection losses, purging losses, or viscosity effects.

ISs shall be added to environmental samples, controls, and blanks, in accordance with the method requirements.

When the IS results are outside of the acceptance limits, corrective actions shall be performed. After the system problems have been resolved and system control has been reestablished, all samples analyzed while the system was malfunctioning shall be reanalyzed. If corrective actions are not performed or are ineffective, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to the sample results.

4.4.5 Retention Time Windows

Retention time windows are used in GC and high performance liquid chromatography (HPLC) analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. The procedure and calculation method are given in SW-846 Method 8000B.

When the retention time is outside of the acceptance limits, corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, reanalyze all samples analyzed since the last acceptable retention time check. If corrective actions are not performed, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to the sample results.

4.4.6 Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations.

The ICS is used to verify background and interelement correction factors.

The ICS is run at the beginning and end of each run sequence.

When the interference check sample results are outside of the acceptance limits stated in the method, corrective action shall be performed. After the system problems have been resolved and system control has been reestablished, reanalyze the ICS. If the ICS result is acceptable, reanalyze all affected samples. If corrective action is not performed or the corrective action was ineffective, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to all affected results.

4.4.7 Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure.

The method blank is used to document contamination resulting from the analytical process.

A method blank shall be included in every AFCEE analytical batch.

The presence of analytes in a method blank at concentrations equal to or greater than the RL indicates a need for corrective action. Corrective action shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples in the analytical batch shall be repreped and reanalyzed. No analytical data shall be corrected for the presence of analytes in blanks. When an analyte is detected in the method blank and in the associated samples and corrective actions are not performed or are ineffective, the appropriate validation flag, as described in Sections 7 and 8, shall be applied to the sample results.

4.4.8 Ambient Blank

The ambient blank consists of ASTM Type II reagent grade water poured into a volatile organic compound (VOC) sample vial at the sampling site (in the same vicinity as the associated samples). It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection.

The frequency of collection for ambient blanks is specified in Section 3.2 of the FSP. Ambient blanks shall be collected downwind of possible VOC sources.

4.4.9 Equipment Blank

An equipment blank is a sample of ASTM Type II reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis.

Equipment blanks are used to assess the effectiveness of equipment decontamination procedures.

The frequency of collection for equipment blanks is specified in Section 3.2 of the FSP. Equipment blanks shall be collected immediately after the equipment has been decontaminated. The blank shall be analyzed for all laboratory analyses requested for the environmental samples collected at the site.

When an analyte is detected in the equipment blank the appropriate validation flag, as described in Section 8, shall be applied to all sample results from samples collected with the affected equipment.

4.4.10 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures.

When an analyte is detected in the trip blank the appropriate validation flag, as described in Section 8, shall be applied to all sample results from samples in the cooler with the affected trip blank.

One trip blank shall accompany each cooler of samples sent to the laboratory for analysis of VOCs.

4.4.11 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the sample collection process. Precision of soil samples to be analyzed for VOCs is assessed from collocated samples because the compositing process required to obtain uniform samples could result in loss of the compounds of interest.

The frequency of collection for field duplicates is specified in Section 3.2 of the FSP.

4.4.12 Field Replicates

A field replicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field such that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection.

Replicate sample results are used to assess precision.

The frequency of collection for field replicates is specified in Section 3.2 of the FSP.

4.5 QUALITY CONTROL PROCEDURES

4.5.1 Holding Time Compliance

All sample preparation and analysis shall be completed within the method-required holding times. The holding time for a sample begins at the time of sample collection. Some methods have more than one holding time requirement (e.g., methods SW8081A, SW8270C, etc.). The preparation holding time is calculated from the time of sample collection to the time of completion of the sample preparation process as described in the applicable method, prior to any necessary extract cleanup and/or volume reduction procedures. If no preparation (e.g., extraction) is required, the analysis holding time is calculated from the time of sample collection to the time of completion of all analytical runs, including dilutions, second column confirmations, and any required reanalyses. In methods requiring sample preparation prior to analysis, the analysis holding time is calculated from the time of preparation completion to the time of completion of all analytical runs, including dilutions, second column confirmations, and any required reanalyses.

If holding times are exceeded and the analyses are performed, the results shall be flagged according to the procedures as described in Section 8.

4.5.2 Confirmation

Quantitative confirmation of results at or above the RL for samples analyzed by GC or HPLC shall be required, unless otherwise specified for the method in Section 7, and shall be completed within the method-required holding times. For GC methods, a second column is used for confirmation. For HPLC methods, a second column or a different detector is used. The result of the first column/detector shall be the result reported. If holding times are exceeded and the

analyses are performed, the results shall be flagged according to the procedures as described in Section 8.

4.5.3 Standard Materials

Standard materials, including second source materials, used in calibration and to prepare samples shall be traceable to National Institute Standards and Technology (NIST), EPA, American Association of Laboratory Accreditation (A2LA) or other equivalent AFCEE approved source, if available. If an NIST, EPA or A2LA standard material is not available, the standard material proposed for use shall be included in an addendum to the SAP and approved before use. The standard materials shall be current, and the following expiration policy shall be followed: The expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date or one year from the date of receipt, whichever comes first. Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first. Expiration dates for pure chemicals shall be established by the laboratory and be based on chemical stability, possibility of contamination, and environmental and storage conditions. Expired standard materials shall be either revalidated prior to use or discarded. Revalidation may be performed through assignment of a true value and error window statistically derived from replicate analyses of the material as compared to an unexpired standard. The laboratory shall label standard and QC materials with expiration dates.

A second source standard is used to independently confirm initial calibration. A second source standard is a standard purchased from a different vendor than the vendor supplying the material used in the initial calibration standards. The second source material can be used for the continuing calibration standards or for the LCS (but shall be used for one of the two). Two different lot numbers from the same vendor do not constitute a second source.

4.5.4 Supplies and Consumables

The laboratory shall inspect supplies and consumables prior to their use in analysis. The materials description in the methods of analysis shall be used as a guideline for establishing the acceptance criteria for these materials. Purity of reagents shall be monitored by analysis of LCSs. An inventory and storage system for these materials shall assure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

5.0 SAMPLING PROCEDURES

5.1 FIELD SAMPLING

The field sampling procedures for collecting samples and sampling methods shall be included in Section 6.0 of the FSP.

5.1.1 Sample Containers

Sample containers are purchased precleaned and treated according to EPA specifications for the methods. Sampling containers that are reused are decontaminated between uses by the EPA-recommended procedures (i.e., EPA 540/R-93/051). Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles are used routinely where glass containers are specified in the sampling protocol.

5.1.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on AFCEE samples are listed in Table 5.1.2-1. The required sample volumes, container types, and preservation requirements for analytical methods proposed for project work not listed in Table 5.1.2-1 shall be included in an addendum to the FSP and approved by AFCEE before use.

Table 5.1.2-1. Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Alkalinity	E310.1	P, G	4°C	50 mL	14 days
Common anions	SW9056	P, G	None required	50 mL	28 days for Br^-, F^-, Cl^-, and SO_4^{-2}; 48 hours for NO_3^-, NO_2^- and PO_4^{-3}
Cyanide, total and amenable to chlorination	SW9010B SW9012A	P, G, T	4°C; NaOH to pH > 12, 0.6 g ascorbic acid	500 mL or 4 ounces	14 days (water and soil)
Filterable residue	E160.1	P, G	4°C	100 mL	7 days
Nonfilterable residue	E160.2	P, G	4°C	100 mL	7 days
Hydrogen ion (pH) (W, S)	SW9040B/ SW9045C	P, G	None required	N/A	Analyze immediately
Nitrogen, nitrate+nitrite	E353.1	P, G	4°C, H_2SO_4 to pH < 2	500 mL	28 days
Conductance	SW9050A	P, G	None required	N/A	Analyze immediately
Temperature	E170.1	P, G	None required	N/A	Analyze immediately
Dissolved oxygen	E360.1	G	None required	500 mL	Analyze immediately
Turbidity	E180.1	P, G	4°C	N/A	48 hours
Total organic carbon	SW9060	P, G, T	4°C, HCl or H_2SO_4 to pH < 2	500 mL	28 days
Chromium (VI)	SW7196A	P, G, T	4°C	500 mL or 8 ounces	24 hours (water); 30 days until extraction and 4 days after extraction (soil)
Mercury	SW7470A SW7471A	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Metals (except chromium (VI) and mercury)	SW6010B SW6020 and SW-846 AA methods	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.

Table 5.1.2-1. Continued

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Total petroleum hydrocarbons (TPH)-volatile	SW8015 (modified)	G, Teflon-lined septum, T	4°C, HCl to pH < 2	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Total petroleum hydrocarbons (TPH)-extractable	SW8015 (modified)	G, amber, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Aromatic and Halogenated volatiles	SW8021B	G, Teflon-lined septum, T	4°C, HCl to pH < 2, 0.008% $Na_2S_2O_3$	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Nitrosamines	SW8070A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Chlorinated herbicides	SW8151A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.

Table 5.1.2-1. Continued

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Organochlorine pesticides	SW8081A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Polychlorinated biphenyls (PCBs)	SW8082	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organophosphorus pesticides/ compounds	SW8141A	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Semivolatile organics	SW8270C	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8260B	G, Teflon-lined septum, T	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics)[b]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.

Table 5.1.2-1. Concluded

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Polynuclear aromatic hydrocarbons (PAHs)	SW8310	G, Teflon-lined cap, T	4°C, store in dark, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Dioxins and furans	SW8280A SW8290	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$ (kept dark)	1 liter or 8 ounces	30 days until extraction and 45 days after extraction (water and soil)
Ethylene dibromide (EDB)	SW8011	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	2 x 40 mL	28 days (water)
Explosive residues	SW8330	P, G, T	Cool, 4°C	1 liter or 8 ounces	7 days to extraction (water); 14 days to extraction (soil); analyze-within 40 days after extraction
TCLP	SW1311	G, Teflon-lined cap, T	Cool, 4°C	1 liter or 8 ounces	14 days to TCLP extraction and 14 days after extraction (volatiles); 14 days to TCLP extraction, 7 days to prep extraction and 40 days after prep extraction (semivolatiles); 28 days to TCLP extraction and 28 days after extraction (mercury); 180 days to TCLP extraction and 180 days after extraction (metals)
Volatile Organics	TO-14	SUMMA® canister	none		14 days

a. Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Preservation with 0.008 percent $Na_2S_2O_3$ is only required when residual chlorine is present.

5.2 SAMPLE HANDLING AND CUSTODY

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

The contractor shall maintain chain-of-custody records for all field and field Quality Control (QC) samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession, (2) it is in their view, after being in their possession, (3) it was in their possession and they locked it up or, (4) it is in a designated secure area.

The following information concerning the sample shall be documented on the AFCEE chain of custody (COC) form (as illustrated in Section 8):

- Unique sample identification
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples shall be uniquely identified, labeled, and documented in the field at the time of collection in accordance with (IAW) Section 6.2 of the FSP.

Samples collected in the field shall be transported to the laboratory or field testing site as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples shall be packed in ice or chemical refrigerant to keep them cool during collection and transportation. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a volatile organics compounds sampling vial filled with tap water) shall be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory. If the temperature of the samples upon receipt exceeds the temperature requirements, the exceedance shall be documented in laboratory records and discussed with AFCEE. The decision regarding the potentially affected samples shall also be documented.

Once the samples reach the laboratory, they shall be checked against information on the COC form for anomalies. The condition, temperature, and appropriate preservation of samples shall be checked and documented on the COC form. Checking an aliquot of the sample using pH paper is an acceptable procedure except for VOCs where an additional sample is required to check preservation. The occurrence of any anomalies in the received samples and their resolution shall be documented in laboratory records. All sample information shall then be entered into a tracking system, and unique analytical sample identifiers shall be assigned. A copy of this information shall be reviewed by the laboratory for accuracy. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods required routinely for AFCEE work are specified in Table 5.1.2-1. **Samples not preserved or analyzed in accordance with these requirements shall be resampled and analyzed, at no additional cost to AFCEE.** Subcontracted analyses shall be documented with the AFCEE COC form. Procedures ensuring internal laboratory COC shall also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch.

While in the laboratory, samples shall be stored in limited-access, temperature-controlled areas. Refrigerators, coolers and freezers shall be monitored for temperature seven days a week. Acceptance criterion for the temperatures of the refrigerators and coolers is 4°C ± 2°C. Acceptance criterion for the temperatures of the freezers shall be less than 0°C . All of the cold storage areas shall be monitored by thermometers that have been calibrated with a NIST-traceable thermometer. As indicated by the findings of the calibration, correction factors shall be applied to each thermometer. Records that include acceptance criteria shall be maintained. Samples for volatile organics determination shall be stored separately from other samples, standards, and sample extracts. Samples shall be stored after analysis until disposed of IAW applicable local, state, and federal regulations. Disposal records shall be maintained by the laboratory.

Standard operating procedures (SOPs) describing sample control and custody shall be maintained by the laboratory.

This page intentionally left blank.

6.0 SCREENING ANALYTICAL METHODS

The analytical screening methods contained in this section are shown in Table 6-1. This section includes brief descriptions of the methods and QC required for screening procedures commonly used to conduct work efforts. The methods and QC procedures were taken from *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition, and its first, second and third update), *Methods for Chemical Analysis of Water and Waste* (U.S. EPA 1979), *ASTM Annual Book of Standards* (1993), and from manufacturers' literature.

Table 6-1. Screening Analytical Methods

Method	Parameter
SW846 (3550)	Moisture
SW1020A	Ignitability
SW1110	Corrosivity
SW9040B	pH (water)
SW9045C	pH (soil)
SW9050A	Conductance
SW9060	Total organic carbon
E160.1	Filterable residue
E160.2	Nonfilterable residue
E170.1	Temperature
E180.1	Turbidity
E310.1	Alkalinity
E360.1	Dissolved oxygen
Organic Vapor (FID and PID)	Soil gas screening-halogenated, aromatic, and petroleum hydrocarbons
ASTM D422	Particle size
ASTM D1498	Oxidation-reduction potential
ASTM D3416	Methane
SW4020	PCBs by Immunoassay
SW4030	TPH by Immunoassay

6.1 ANALYTICAL SCREENING METHOD DESCRIPTIONS

Section 6.1 contains subsections for each analytical procedure. Each subsection contains the following information:

- A brief method description
- The RL (if applicable)

6.1.1 EPA Method SW1020A-Ignitability

Method 1020A makes use of the Setaflash Closed Tester to determine the flash point of liquids that have flash points between 0° and 110°C and viscosities lower than 150 stokes at 25°C.

6.1.2 EPA Method SW1110-Corrosivity

This test exposes steel to liquid waste to determine the corrosivity of the waste.

6.1.3 EPA Method SW9040B (Water)/SW9045C (Soil)–pH

pH measurements shall be performed for water samples using method SW9040. pH measurements of soil samples are performed using method SW9045C. Measurements are determined electrometrically using either a glass electrode in combination with a reference potential, or a combination electrode.

6.1.4 EPA Method SW9050A–Conductance

Standard conductivity meters are used. Temperature is also reported.

6.1.5 EPA Method SW9060–Total Organic Carbon

Organic carbon is measured using a carbonaceous analyzer. This instrument converts the organic carbon in a sample to carbon dioxide by either catalytic combustion or wet chemical oxidation. The carbon dioxide formed is then either measured directly by an infrared detector or converted to methane and measured by a flame ionization detector. The amount of carbon dioxide or methane in a sample is directly proportional to the concentration of carbonaceous material in the sample.

Method	Analyte	Water	
		RL	Unit
SW9060	Total organic carbon	1	mg/L

6.1.6 EPA Method 160.1–Filterable Residue

A well-mixed sample is filtered through a standard glass fiber filter. The filtrate is evaporated and dried to constant weight at 180 °C.

Method	Analyte	Water	
		RL	Unit
E160.1	Total dissolved solids	10	mg/L

6.1.7 EPA Method 160.2–Nonfilterable Residue

A well-mixed sample is filtered through a glass fiber filter, and the residue retained on the filter is dried to constant weight at 103-105 ^{o}C.

Method	Analyte	Water	
		RL	Unit
E160.2	Total suspended solids	5	mg/L

6.1.8 EPA Method 170.1–Temperature

Temperature measurements are made with a mercury-filled or dial type centigrade thermometer, or a thermistor.

6.1.9 EPA Method 180.1–Turbidity

This method is based on a comparison of the light scattered by the sample under defined conditions with the light intensity scattered by a standard reference suspension. The higher the intensity, the greater the turbidity. Turbidity measurements are made in a nephelometer and are reported in terms of nephelometric turbidity units (NTUs). The working range for the method is from 0–40 NTU. Higher levels of turbidity can be measured by diluting the sample with turbidity-free deionized water.

6.1.10 EPA Method 310.1–Alkalinity

In this method, an unaltered sample is titrated to an end point of pH 4.5 using hydrochloric or sulfuric acid.

Method	Analyte	Water	
		RL	Unit
E310.1	Alkalinity[1]	10	mg/L

[1] alkalinity measured as calcium carbonate equivalence

6.1.11 EPA Method 360.1–Dissolved Oxygen

An instrumental probe, usually dependent upon an electrochemical reaction, is used for determination of dissolved oxygen in water. Under steady-state conditions, the current or potential can be correlated with dissolved oxygen concentrations.

6.1.12 ASTM D422–Standard Method for Particle-Size Analysis of Soils

This method covers the quantitative determination of the distribution of particle sizes in soils. The distribution of particle sizes larger than 75 µm (retained on the No. 200 sieve) is determined by sieving, while the distribution of particle sizes smaller than 75 µm is determined by a sedimentation process using a hydrometer.

6.1.13 ASTM D1498–Oxidation-Reduction Potential

This method is designed to measure the oxidation-reduction potential (ORP) in water, which is defined as the electromotive force between a noble metal electrode and a reference electrode when immersed in a solution.

6.1.14 ASTM D3416–Methane in Soil Gas

An aliquot of the soil gas sample is introduced into a prechromatographic or stripper column which removes hydrocarbons other than methane and carbon monoxide. Methane and carbon monoxide are passed through a chromatographic column where they are separated. The methane is measured by a flame ionization detector (FID). Quantitation is performed by comparing the sample response to the response of a known concentration of methane.

6.1.15 EPA Method SW4020–Screening for Polychlorinated Biphenyls by Immunoassay

Soil samples are screened for total polychlorinated biphenyls (PCBs) using immunoassay test kits. A mini methanol extraction of the soil sample is performed, and the extract and an enzyme conjugate reagent are added to immobilized antibodies. The enzyme conjugate competes with the PCBs in the sample for binding to immobilized anti-PCB antibodies. The test is interpreted by comparing the response produced by the sample to the response produced by a standard.

6.1.16 EPA Method SW4030–Screening for Petroleum Hydrocarbons by Immunoassay

Soil samples are screened for levels of total petroleum hydrocarbons (TPH) using TPH test kits. A mini extraction of the soil sample is performed, and the extract and an enzyme conjugate reagent are added to immobilized antibodies. The enzyme conjugate competes with hydrocarbons for binding to immobilized anti-hydrocarbon antibodies. The test is interpreted by comparing the response produced by the sample to the response produced by a standard.

6.1.17 SW-846 (Described in Method SW3550)–Percent Moisture

Percent moisture is determined for solid samples undergoing analysis for inorganic and organic analytes. The sample is weighed, dried, and then reweighed. Percent moisture is calculated as:

$$\frac{\text{Initial Weight - Dried Weight}}{\text{Initial Weight}} \times 100 = \%\text{ moisture}$$

The moisture content is used to calculate results for soil samples on a dry weight basis using the calculation presented below:

$$\frac{\text{Result of analysis on wet weight basis}}{1 - (\%\text{ Moisture}/100)} = \text{Result of analysis on a dry weight basis}$$

All soil or sediment results and MDLs shall be reported on a dry weight basis.

6.1.18 Real-Time Portable Organic Vapor Analyzers

Two types of portable analyzers shall be used to perform real-time nonspecific analyses of hydrocarbon vapors. The instruments include an FID (e.g., Foxboro Century OVA) and a photoionization detector (PID) (e.g., HNu® Systems [HNu®] trace gas analyzer) organic vapor monitor. One or more of these instruments may be used at a specific site, depending on the contaminant species of interest. When used together, the instruments provide complementary information because they are sensitive to different types of hydrocarbon vapors.

The portable analyzers shall be used as a screening tool to help determine the optimum locations for the collection of samples. Field data recorded on the COC forms give the laboratory analysts an indication of the approximate concentration of contaminants and aid in calculating dilution factors before analysis. Additionally, the real-time instruments are used to aid in selecting the proper level of personal protective equipment and monitoring air emissions during sampling activities. The comparability of results obtained from the PID and FID instruments can be considered only to be within the variability of this type of screening instrument. Comparability is greatest when the instruments are calibrated with the same standards and operated within similar concentration ranges.

The FID uses the principle of hydrogen flame ionization to detect and measure total hydrocarbon vapors. The FID has a dynamic operating range from 1 ppmv to 10 ppmv or 1 ppmv to 100,000 ppmv, depending on the instrument, and provides a nonspecific response to total hydrocarbons. If concentrations exceed the range of the instrument, a dilution probe shall be attached to the FID to allow elevated vapor concentrations to be measured. The instrument is highly sensitive to

compounds such as methane, benzene, and acetone, but is less sensitive to alcohols and halogenated compounds.

During operation, a sample is drawn into the probe and transmitted to the detection chamber by an internal pumping system. Inside the chamber, the sample is exposed to a hydrogen flame that ionizes the organic vapors. As the organic vapors burn, the ions produced are collected on an electrode in the chamber, and a current proportional to the hydrocarbon concentration is generated. This current is measured and displayed on the meter.

The PID uses a photoionization detector to detect and measure total hydrocarbon vapors. The instrument has an operating range of 0-2,000 ppm. During operation, a gas sample is drawn into the probe and past an ultraviolet light source by an internal pumping system. Contaminants in the sample are ionized, producing an instrument response if their ionization potential is equal to or less than the ionizing energy supplied by the lamp. The radiation produces a free electron for each molecule of ionized contaminant, which generates a current directly proportional to the number of ions produced. This current is measured and displayed on the meter. The PID measures the *total* value for all species present with ionization potentials less than or equal to that of the lamp.

6.2 CALIBRATION AND QC PROCEDURES FOR SCREENING METHODS

All screening data shall be flagged with an "S" data qualifier to show the reported data are screening data (see Section 8). The other data qualifiers that shall be used with screening data are also shown in Table 6.2-1 and Section 8. Flagging criteria are applied (except for the "S" flag) when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

Table 6.2-1 presents the calibration and QC procedures for each method. These requirements as well as the corrective actions and data flagging criteria are included. In this table, the first two columns designate the method number and the class of analytes that may be determined by the method. The third column lists the method-required calibration and QC elements. The fourth column designates the minimum frequency for performing each calibration and QC element. The fifth column designates the acceptance criteria for each calibration and QC element. The sixth column designates the corrective action in the event that a calibration or QC element does not meet the acceptance criteria. The last column designates the data flagging criteria that must be applied in the event that the method-required calibration and QC acceptance criteria are not met.

Table 6.2-1. Summary of Calibration and QC Procedures for Screening Methods

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
SW-846[c]	Moisture	Duplicate sample	1 per 20 samples	% solid RPD ≤ 15%	Correct problem, repeat measurement. If still out, flag data	J if RPD >15% and ≤30% R if RPD > 30%
SW9045C	pH (soil)	2-point calibration with pH buffers	1 per 10 samples analyzed	± 0.05 pH unit	Check with new buffers; if still out, repair meter; repeat calibration check	R
		pH 7 buffer	At each sample location	± 0.1 pH unit	Recalibrate	R
		Duplicate sample	10% of field samples	± 0.1 pH unit	Correct problem, repeat measurement. If still out, repeat calibration and reanalyze samples	J
SW9050A	Conductanc e	Calibration with KCl standard	Once per day at beginning of testing	± 5%	If calibration is not achieved, check meter, standards, and probe; recalibrate	R
		Field duplicate	10% of field samples	± 5%	Correct problem, repeat measurement	J
SW9040B	pH (water)	2-point calibration with pH buffers	Once per day	± 0.05 pH units for every buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration	R
		pH 7 buffer	At each sample location	± 0.1 pH units	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 0.1 pH units	Correct problem, repeat measurement	J
E170.1	Temperature	Field duplicate	10% of field samples	± 1.0°C	Correct problem, repeat measurement	J

a. All corrective actions shall be documented, and the records shall be maintained by the prime contractor.
b. All screening results shall first be flagged with an "S" and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example "SJ", "SB", "SR".
c. Described in method SW3550.

Table 6.2-1. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
E180.1	Turbidity	Calibration with one formazin standard per instrument range used	Once per day at beginning of testing	± 5 units, 0–100 range ± 0.5 units, 0–0.2 range ± 0.2 units, 0–1 range	If calibration is not achieved, check meter; replace if necessary, recalibrate	R
		Field duplicate	10% of field samples	RPD ≤ 20%	Correct problem, repeat measurement	J
None	Organic vapor concentration s (FID and PID)	3 point calibration	Monthly	correlation coefficient ≥ 0.995	Recalibrate; check instrument and replace if necessary	R
		Calibration verification and check	Daily at beginning and end of day	Response ± 20% of expected value	Correct problem, recalibrate	R
SW9060	Total organic carbon	Method blank	Daily or one per batch, whichever is more frequent	< RL	Clean system; reanalyze blank. Repeat until analyte < RL	B
		Field duplicate	10% of field samples	RPD < 20%	Repeat measurement	J
E160.1	Filterable residue	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E160.2	Nonfilterable residue	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
ASTM D1498	Oxidation-reduction potential	Sensitivity verification	Daily	ORP should decrease when pH is increased	If ORP increases, correct the polarity of electrodes. If ORP still does not decrease, clean electrodes and Repeat procedure	R
		Calibration with one standard	Once per day	Two successive readings ± 10 millivolts	Correct problem, recalibrate	R
		Field duplicate	10% of field samples	± 10 millivolts	Correct problem, repeat measurement	J

a. All corrective actions shall be documented, and the records shall be maintained by the prime contractor.
b. All screening results shall first be flagged with an “S” and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example “SJ”, “SB”, “SR”.

Table 6.2-1. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Data Flagging Criteria[b]
SW1110	Corrosivity	Duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E310.1	Alkalinity	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
E360.1	Dissolved oxygen	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
SW4020	PCBs by immunoassay	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
SW4030	Petroleum hydrocarbons by immunoassay	Field duplicate	10% of field samples	RPD < 20%	Correct problem, repeat measurement	J
ASTM D3416	Methane	Single point calibration	Daily, prior to sample analysis	Delineation from database average within ± 20%	Recalibrate	R
		Method blank	Daily or one per batch, whichever is more frequent	< RL	Clean system; reanalyze blank and Repeat until all analytes < RL	B
		Duplicate	1 per batch or 10%	RPD ≤ 20%	Analyze third aliquot: if still out, flag data	J

a. All corrective actions shall be documented, and the records shall be maintained by the prime contractor.
b. All screening results shall first be flagged with an “S” and also any other appropriate validation flags identified in the Data Flagging Criteria column of the table. For example “SJ”, “SB”, “SR”.

This page intentionally left blank.

7.0 DEFINITIVE DATA ANALYTICAL METHODS AND PROCEDURES

Section 7.1 contains brief descriptions of preparation methods. Section 7.2 contains subsections for each analytical procedure. Each subsection contains the following information:

- A brief method description
- A table of RLs
- A table of QC acceptance criteria
- A table of calibration procedures, QC procedures, and data validation guidelines

This information was obtained from the *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition, and its first, second and third update); *Handbook for the Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)* (Handbook), September 1993; *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, U.S. EPA, Office of Solid Waste and Emergency Response, Washington, D.C., Publication 9240.1-05-01, EPA-540/R-94-013, PB94-963502, February 1994; and *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, U.S. EPA, Office of Solid Waste and Emergency Response, Washington, D.C., Publication 9240.1-05, EPA-540/R-94-012, PB94-963501, February 1994. Definitions of terms are given in Section 4.0, and data validation procedures are presented in Section 8.0.

7.1 PREPARATION METHODS

Extraction and digestion procedures for liquid and solid matrices presented in this section are outlined in Table 7.1-1. The appropriate preparation method to be used (if applicable) for each analytical method is given in the RL tables.

Table 7.1-1. Extraction and Digestion Procedures

Method	Parameter
SW1311	Toxicity Characteristic Leaching Procedure
SW3005A	Acid Digestion of Water Samples for Metals Analysis
SW3010A	Acid Digestion of Aqueous Samples and Extracts for Metals Analysis
SW3015	Microwave Assisted Acid Digestion of Aqueous Samples and Extracts for Metals Analysis
SW3020A	Acid Digestion of Aqueous Samples and Extracts for Metals Analysis
SW3050B	Acid Digestion of Solids, Sediments, and Sludges for Metals Analysis
SW3051	Microwave Assisted Acid Digestion of Solids, Sediments, and Sludges for Metals Analysis
SW3060A	Alkaline Digestion for Hexavalent Chromium
SW3510C	Separatory Funnel Liquid-Liquid Extraction
SW3520C	Continuous Liquid-Liquid Extraction
SW3535	Solid-Phase Extraction
SW3540C/SW3541	Soxhlet Extraction
SW3545	Pressurized Fluid Extraction
SW3550B	Ultrasonic Extraction
SW3585	Waste Dilution for Volatile Organics
SW5021	Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis
SW5030B	Purge and Trap
SW5031	Volatile, Nonpurgeable, Water-Soluble Compounds by Azeotropic Distillation
SW5032	Volatile Organic Compounds by Vacuum Distillation
SW5035	Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples

7.1.1 Method SW1311–Toxicity Characteristic Leaching Procedure

Method SW1311 is used to prepare samples for determination of the concentration of organic (semivolatile and volatile) and inorganic constituents that are leachable from waste or other material.

QC is accomplished by preparing a toxicity characteristic leaching procedure (TCLP) blank at a rate of one blank for every 20 extractions conducted in the extraction vessel. Additional extract is prepared so one MS is performed for each waste type (samples of similar waste types shall be batched together). One MS must be analyzed in each AFCEE analytical batch. These QA measures are in accordance with the requirements of EPA method SW1311, Section 8.0.

7.1.2 Method SW3005A–Acid Digestion of Water Samples for Metals Analysis

This method is an acid digestion procedure used to prepare water samples for metals analysis. The digested samples are analyzed for total recoverable and dissolved metals determination by inductively coupled plasma (ICP).

For analysis of total recoverable metals, the entire sample is acidified at collection time. For analysis of dissolved metals, upon collection the samples are filtered then acidified.

7.1.3 Method SW3010A–Acid Digestion of Aqueous Samples and Extracts for Metals Analysis

Method SW3010A prepares aqueous or waste samples for total metals determination by ICP. The samples are vigorously digested with acid and then diluted.

7.1.4 Method SW3015–Microwave Assisted Acid Digestion of Aqueous Samples and Extracts for Metals Analysis

This method is used to prepare aqueous or waste samples that contain suspended solids, for total metals determination by graphite furnace atomic absorption spectroscopy (GFAA) or ICP. The samples are digested with acid and heated in a microwave.

7.1.5 Method SW3020A–Acid Digestion of Aqueous Samples and Extracts for Metals Analysis

Method SW3020A prepares aqueous or waste samples for total metals determination by GFAA or ICP. The samples are vigorously digested with acid and then diluted.

7.1.6 Method SW3050B–Acid Digestion of Solids, Sediments, and Sludges for Metals Analysis

Method SW3050B is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by ICP or, for some metals, by GFAA. A sample is digested then refluxed with acid. A separate aliquot of the sample is dried for a total solids and/or percent moisture determination.

7.1.7 Method SW3051–Microwave Assisted Acid Digestion of Solids, Sediments, and Sludges for Metals Analysis

Method SW3051 is applicable to the preparation of sediment, sludge, and soil samples for metals analysis by GFAA or ICP. The samples are digested with acid and heated in a microwave. A separate aliquot of the sample is dried for a total solids and/or percent moisture determination.

7.1.8 Method SW3060A–Alkaline Digestion for Hexavalent Chromium

Method SW3060A is applicable to the preparation of sediment, sludge, and soil samples for analysis of hexavalent chromium by UV-VIS spectrophotometry. The samples are digested with sodium hydroxide.

7.1.9 Method SW3510C-Separatory Funnel Liquid-Liquid Extraction

Method SW3510C is designed to quantitatively extract nonvolatile and SVOCs from liquid samples using standard separatory funnel techniques. The sample and the extracting solvent must be immiscible in order to yield recovery of target compounds. Subsequent cleanup and detection methods are described in the organic analytical method used to analyze the extract.

7.1.10 Method SW3520C-Continuous Liquid-Liquid Extraction

Method SW3520C is a procedure for isolating organic compounds from aqueous samples and is designed for extraction solvents with greater density than the sample.

7.1.11 Method SW3535-Solid-Phase Extraction

Method SW3535 is a procedure for isolating organic compounds from aqueous samples using solid-phase extraction media.

7.1.12 Method SW3540C/SW3541-Soxhlet Extraction

Method SW3540C is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. Method SW3541 is an automated Soxhlet extraction. The Soxhlet extraction process ensures intimate contact of the sample matrix with the extraction solvent.

7.1.13 Method SW3545-Pressurized Fluid Extraction

Method SW3545 is a procedure for extracting water insoluble or slightly water soluble semivolatile organic compounds from soils, sediments, sludges, and waste solids using elevated temperature and pressure.

7.1.14 Method SW3550B-Ultrasonic Extraction

Method SW3550B is a procedure for extracting nonvolatile and SVOCs from solids such as soils and sludges. The sonication process ensures intimate contact of the sample matrix with the extraction solvent.

7.1.15 Method SW3585-Waste Dilution for Volatile Organics

Method SW3585 is a procedure describing a solvent dilution of a non-aqueous waste sample prior to direct injection analysis.

7.1.16 Method SW5021-Volatile Organic Compounds in Soils and Other Solid Matrices Using Equilibrium Headspace Analysis

Method SW5021 is a general purpose method for the preparation of VOCs in soils, sediments and solid wastes by GC or GC/MS analysis.

7.1.17 Method SW5030B-Purge and Trap

Method SW5030B describes sample preparation and extraction for the analysis of VOCs. The method is applicable to nearly all types of samples, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, water, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The success of this method depends on the level of interferences in the sample. Results may vary due to the large variability and complexity of matrices of solid waste samples.

An inert gas is then bubbled through the sample solution at ambient temperature to transfer the volatile components to the vapor phase. The vapor is swept through a sorbent column where the volatile components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a GC column.

7.1.18 Method SW5031-Volatile, Nonpurgeable, Water-Soluble Compounds by Azeotropic Distillation

Method SW5031 is a method for separating nonpurgeable water-soluble and VOCs in aqueous or leachates from solid matrices using azeotropic distillation.

7.2.19 Method SW5032-Volatile Organic Compounds by Vacuum Distillation

Method SW5032 is a method used to determine volatile organic compounds from a variety of matrices using vacuum distillation.

7.1.20 Method SW5035-Closed System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples

Method SW5035 is a method for analyzing VOCs in solid matrices.

7.2 ANALYTICAL PROCEDURES

The analytical procedures presented in this section are outlined in Table 7.2-1.

A brief description and three tables for each method are included in the following subsections. The first table presents the RLs for each analyte in the method. The RLs are presented for both soil and water matrices. The second table presents the acceptance criteria for the accuracy of spiked analyte and surrogate recoveries. This table also presents the acceptance criteria for the precision of matrix, field, and laboratory duplicate recoveries. The third table presents the calibration and QC procedures for each method. Corrective actions and data flagging criteria are also included in this table.

In the third table, the first two columns designate the method number and the class of analytes that may be determined by the method. The third column lists the method-required calibration and QC elements. The fourth column designates the minimum frequency for performing each calibration and QC element. The fifth column designates the acceptance criteria for each calibration and QC element. The sixth column designates the corrective action in the event that a calibration or QC element does not meet the acceptance criteria. The last column designates the data flagging criteria that shall be applied in the event that the method-required calibration and QC acceptance criteria are not met.

Table 7.2-1. Analytical Procedures

Analytical Method	Parameter	Preparatory Methods
8011	Ethylene dibromide (EDB) (water)	8011, 5030B
8015 (modified)	TPH volatile and extractable (water and soil)	(volatiles) 5030B, 5031, 5035 (extractables) 3510C, 3520C, 3545C, 3541, 3545, 3550B
8021B	Aromatic and halogenated volatile organics (water and soil)	3585, 5021, 5030B, 5035
8070A	Nitrosamines (water and soil)	3510C, 3520C, 3540C, 3541, 3545, 3550B
8081A	Organochlorine pesticides (water and soil)	3510C, 3520C, 3540C, 3541, 3545, 3550B
8082	PCBs (water and soil)	3510C, 3520C, 3540C, 3541
8141A	Organophosphorus compounds (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
8151A	Chlorinated herbicides (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
8260B	Volatile organics (water and soil)	3585, 5021, 5030B, 5031, 5032, 5035
8270C	Semivolatile organics (water and soil)	3510C, 3520C, 3540C, 3541, 3545, 3550B
8280A/8290	Dioxins and furans (water and soil)	(see analytical method)
8310	Polynuclear aromatic hydrocarbons (PAHs) (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
8330	Explosive residues (water and soil)	3510C, 3520C, 3540C, 3541, 3550B
6010B	Trace metals by ICPES (water and soil)	3005A, 3010A, 3015, 3050B, 3051
6020	Trace metals by ICP-MS (water and soil)	3005A, 3010A, 3015, 3050B, 3051
7041	Antimony (water and soil)	(see analytical method), 3005A
7060A	Arsenic (water and soil)	(see analytical method), 3050B
7131A	Cadmium (water and soil)	3015, 3020A, 3050B, 3051
7191	Chromium (water and soil)	3015, 3020A, 3050B, 3051
7196A	Hexavalent chromium	3060A
7421	Lead (water and soil)	3015, 3020A, 3050B, 3051
7470A	Mercury (water)	(see analytical method)
7471A	Mercury (soil)	(see analytical method)
7521	Nickel (water and soil)	3015, 3020A, 3050B, 3051
7740	Selenium (water and soil)	(see analytical method), 3050B
7841	Thallium (water and soil)	3015, 3020A, 3050B, 3051
7911	Vanadium (water and soil)	3015, 3020A, 3050B, 3051
9010B	Cyanide (water)	(see analytical method)
9012A	Cyanide (water)	(see analytical method)
9056	Common anions	N/A
TO-14	Volatile Organics in Ambient Air	N/A

7.2.1 Method SW8011-Ethylene Dibromide

Ethylene dibromide (EDB) in water is analyzed using method SW8011. The sample is extracted with hexane. The extract is injected into a GC with a linearized electron capture detector for separation and analysis. The RL is presented in Table 7.2.1-1.

This method provides for the use of a second GC column of dissimilar phase to resolve compounds of interest from interferences that may occur. When second-column analysis is performed, retention times for the analyte must match those established for each column. Otherwise, the chromatographic peaks are considered interferences, and the analyte is not considered to be present in the sample. Requirements for confirmation of the analyte are described in Section 4.5.2. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.1-2 and 7.2.1-3.

Table 7.2.1-1. RL for Method SW8011

Parameter/Method	Analyte	Water	
		RL	Unit
SW8011	EDB	0.1	μg/L

Table 7.2.1-2. QC Acceptance Criteria for Method SW8011

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
SW8011	EDB	85-115	≤ 15

Table 7.2.1-3. Summary of Calibration and QC Procedures for Method SW8011

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8011	EDB	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to the result for EDB for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to the result for EDB for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to the result for EDB in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to the result for EDB for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to the result for EDB in all samples since the last acceptable calibration verification

Table 7.2.1-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8011	EDB	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.1-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to the EDB result for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to the result for EDB in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.1-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For EDB in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.1-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.1-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8011	EDB	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.1-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.1-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.2 Method SW8015 (Modified)-Volatile and Extractable Total Petroleum Hydrocarbons

Volatile petroleum hydrocarbon components, such as gasoline, jet fuel, and other low molecular weight petroleum products, are analyzed by the direct purge and trap technique described in method SW5030B followed by a modified approach to method SW8015. Extractable TPH components are analyzed by extraction method SW3520C or SW3550B followed by a modified method SW8015.

For volatile TPH, the sample is placed in the purge and trap sparge vessel and analysis is conducted using a GC equipped with a FID.

Extractable TPH components, such as kerosene, diesel, motor oil, and other high molecular weight extractable petroleum products, are analyzed by method SW3520C (continuous liquid/liquid extraction) for water-based matrices or by method SW3550B (sonication extraction) for soil/sludge matrices. The sample is extracted and analysis is accomplished on a GC equipped with a capillary or megabore column and a FID. RLs for volatile TPH and extractable TPH are provided in Table 7.2.2-1.

Identification and quantitation of TPH components require more analytical judgment than other GC methods. The TPH chromatograms consist of groups of peaks that fall within a noted carbon retention time range (i.e., number of carbon atoms in the molecule). Standard fuel components are used to calibrate the instruments. The total petroleum hydrocarbons results are reported in mg/kg or mg/L based on quantitation of the total area count for the gasoline range organics (i.e., C6-C10) or the diesel range organics (i.e., C10-C28). The retention time window shall be set such that the window encompasses only the C6 through C28 range of organics. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.2-2 and 7.2.2-3. Second column confirmation is not required.

Table 7.2.2-1. RLs for Method SW8015 (Modified)

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Petroleum Hydrocarbons SW8015 (Mod)	Gasoline	0.1	mg/L	1.0	mg/kg
	Diesel	1.0	mg/L	10.0	mg/kg
	Jet Fuel	1.0	mg/L	10.0	mg/kg

Table 7.2.2-2. QC Acceptance Criteria for Method SW8015 (Modified)

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8015 (Modified) GRO	TPH–Gasoline	67–136	≤ 30	57–146	≤ 50
	Surrogate:				
	Chlorobenzene	74–138		64–148	
SW8015 (Modified) DRO	TPH–Diesel	61–143	≤ 30	51–153	≤ 50
	TPH–Jet Fuel	61–143	≤ 30	51–153	≤ 50
	Surrogates (choose 2):				
	Octacosane	26–152		25–162	
	Ortho-Terphenyl	57–132		47–142	
	Fluorobenzene	75-125		65-135	
	Tricontane	40-140		30-150	

Table 7.2.2-3. Summary of Calibration and QC Procedures for Method SW8015 (Modified)

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Initial calibration verification	Daily, before sample analysis	All concentration levels of GRO within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All concentration levels within ±15% of initial calibration	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.2-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst

Table 7.2.2-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	Method blank	One per analytical batch	No TPH detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.2-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.2-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.2-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8015 (mod)	Volatile and Extractable Total Petroleum Hydrocarbons	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.2-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Retention time window calculated	Each initial calibration	GRO – calculate retention time based on 2-methylpentane and 1,2,4-trimethylbenzene (see 7.4.2 in method)	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to the result for EDB in the sample
				DRO - calculate retention time based on C10 and C28 alkanes (see 7.4.3 in method)		
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.2-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.3 Method SW8021B- Aromatic and Halogenated Volatile Organics

Aromatic and halogenated volatile organics in water and soil samples are analyzed using method SW8021B. This method is a purge and trap GC method using preparation method SW5030B. A temperature program is used in the GC to separate the compounds. Detection is achieved by a PID and an electrolytic conductivity detector (HECD) in series. The RLs for the analytes are presented in Table 7.2.3-1. Requirements for confirmation of analytes are described in Section 4.5.2. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.3-2 and 7.2.3-3.

For analytes detected by both detectors, no further confirmation need be performed. For analytes detected by only one detector, confirmation on another column is required.

Table 7.2.3-1. RLs for Method SW8021B

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Aromatic and Halogenated Volatile Organics SW8021B	1,1,1,2-Tetrachloroethane	0.10	µg/L	0.01	mg/kg
	1,1,1-TCA	0.30	µg/L	0.01	mg/kg
	1,1,2,2-Tetrachloroethane	0.10	µg/L	0.01	mg/kg
	1,1,2-TCA	0.30	µg/L	0.01	mg/kg
	1,1-DCA	0.70	µg/L	0.01	mg/kg
	1,1-DCE	0.70	µg/L	0.01	mg/kg
	1,1-Dichloropropene	0.20	µg/L	0.01	mg/kg
	1,2,3-Trichlorobenzene	0.30	µg/L	0.01	mg/kg
	1,2,3-Trichloropropane	4.00	µg/L	0.01	mg/kg
	1,2,4-Trichlorobenzene	0.30	µg/L	0.01	mg/kg
	1,2,4-Trimethylbenzene	0.5	µg/L	0.01	mg/kg
	1,2-Dibromo-3-chloropropane	30.0	µg/L	0.01	mg/kg
	1,2-Dibromoethane	8.00	µg/L	0.01	mg/kg
	1,2-DCA	0.30	µg/L	0.01	mg/kg
	1,2-DCB	0.50	µg/L	0.01	mg/kg
	1,2-Dichloropropane	0.10	µg/L	0.01	mg/kg
	1,3,5-Trimethylbenzene	0.10	µg/L	0.01	mg/kg
	1,3-DCB	0.20	µg/L	0.01	mg/kg
	1,3-Dichloropropane	0.30	µg/L	0.01	mg/kg
	1,4-DCB	0.10	µg/L	0.01	mg/kg
	2,2-Dichloropropane	0.50	µg/L	0.01	mg/kg
	2-Chlorotoluene	0.10	µg/L	0.01	mg/kg
	4-Chlorotoluene	0.20	µg/L	0.01	mg/kg
	Benzene	0.10	µg/L	0.01	mg/kg
	Bromobenzene	0.10	µg/L	0.01	mg/kg
	Bromochloromethane	0.10	µg/L	0.01	mg/kg
	Bromodichloromethane	0.20	µg/L	0.01	mg/kg
	Bromoform	16.0	µg/L	0.01	mg/kg
	Bromomethane	11.00	µg/L	0.01	mg/kg
	Carbon Tetrachloride	0.10	µg/L	0.01	mg/kg
	Chlorobenzene	0.10	µg/L	0.01	mg/kg
	Chloroethane	1.00	µg/L	0.01	mg/kg
	Chloroform	0.20	µg/L	0.01	mg/kg
	Chloromethane	0.30	µg/L	0.01	mg/kg
	Cis-1,2-DCE	0.60	µg/L	0.01	mg/kg
	Cis-1,3-Dichloropropene	0.30	µg/L	0.01	mg/kg
	Dibromochloromethane	0.50	µg/L	0.01	mg/kg
	Dibromomethane	22.0	µg/L	0.01	mg/kg
	Dichlorodifluoromethane	0.50	µg/L	0.01	mg/kg
	EDB	8.00	µg/L	0.01	mg/kg
	Ethylbenzene	0.50	µg/L	0.01	mg/kg
	Hexachlorobutadiene	0.60	µg/L	0.01	mg/kg
	Isopropylbenzene	0.50	µg/L	0.01	mg/kg
	m-Xylene	0.10	µg/L	0.01	mg/kg
	Methylene Chloride	0.20	µg/L	0.01	mg/kg

Table 7.2.3-1. Concluded

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Aromatic and Halogenated Volatile Organics SW8021B	n-Butylbenzene	0.50	µg/L	0.01	mg/kg
	n-Propylbenzene	0.10	µg/L	0.01	mg/kg
	Naphthalene	0.60	µg/L	0.01	mg/kg
	o-Xylene	0.20	µg/L	0.01	mg/kg
	p-Isopropyltoluene	0.10	µg/L	0.01	mg/kg
	p-Xylene	0.10	µg/L	0.01	mg/kg
	Sec-Butylbenzene	0.20	µg/L	0.01	mg/kg
	Styrene	0.10	µg/L	0.01	mg/kg
	TCE	0.20	µg/L	0.01	mg/kg
	Tert-Butylbenzene	0.60	µg/L	0.01	mg/kg
	Tetrachloroethylene	0.50	µg/L	0.01	mg/kg
	Toluene	0.10	µg/L	0.01	mg/kg
	Trans-1,2-DCE	0.60	µg/L	0.01	mg/kg
	Trans-1,3-Dichloropropene	1.00	µg/L	0.01	mg/kg
	Trichlorofluoromethane	0.30	µg/L	0.01	mg/kg
	Vinyl Chloride	0.40	µg/L	0.01	mg/kg
	Xylenes, Total	0.50	µg/L	0.01	mg/kg

Table 7.2.3-2. QC Acceptance Criteria for Method SW8021B

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8021B	1,1,1,2-Tetrachloroethane	75–125	≤ 20	65–125	≤ 30
	1,1,1-TCA	69–134	≤ 20	59–134	≤ 30
	1,1,2,2-Tetrachloroethane	30–166	≤ 20	25–166	≤ 30
	1,1,2-TCA	61–130	≤ 20	51–130	≤ 30
	1,1-DCA	64–127	≤ 20	54–127	≤ 30
	1,1-DCE	53–147	≤ 20	43–147	≤ 30
	1,1-Dichloropropene	65-135	≤ 20	55-145	≤ 30
	1,2,3-Trichlorobenzene	65-135	≤ 20	55-145	≤ 30
	1,2,3-Trichloropropane	75–125	≤ 20	65–125	≤ 30
	1,2,4-Trichlorobenzene	65-135	≤ 20	55-145	≤ 30
	1,2,4-Trimethylbenzene	65-135	≤ 20	55-145	≤ 30
	1,2-Dibromo-3-chloropropane	65-135	≤ 20	55-145	≤ 30
	1,2-Dibromoethane	65-135	≤ 20	55-145	≤ 30
	1,2-DCA	68–137	≤ 20	58–137	≤ 30
	1,2-DCB	61–134	≤ 20	51–134	≤ 30
	1,2-Dichloropropane	73–125	≤ 20	63–125	≤ 30
	1,3,5-Trimethylbenzene	65-135	≤ 20	55-145	≤ 30
	1,3-DCB	63–137	≤ 20	53–137	≤ 30
	1,3-Dichloropropane	65-135	≤ 20	55-145	≤ 30
	1,4-DCB	66–135	≤ 20	56–135	≤ 30
	2,2-Dichloropropane	65-135	≤ 20	55-145	≤ 30
	2-Chlorotoluene	65-135	≤ 20	55-145	≤ 30
	4-Chlorotoluene	65-135	≤ 20	55-145	≤ 30
	Benzene	75–125	≤ 20	65–125	≤ 30
	Bromobenzene	75–125	≤ 20	65–125	≤ 30
	Bromochloromethane	65-135	≤ 20	55-145	≤ 30
	Bromodichloromethane	61–135	≤ 20	51–135	≤ 30
	Bromoform	58–129	≤ 20	48–129	≤ 30
	Bromomethane	68–125	≤ 20	58–125	≤ 30
	Carbon Tetrachloride	69–139	≤ 20	59–139	≤ 30
	Chlorobenzene	75–129	≤ 20	65–129	≤ 30
	Chloroethane	75–130	≤ 20	65–130	≤ 30
	Chloroform	49–133	≤ 20	39–133	≤ 30
	Chloromethane	59–154	≤ 20	49–154	≤ 30
	Cis-1,2-DCE	75–120	≤ 20	65–125	≤ 30
	Cis-1,3-Dichloropropene	75–130	≤ 20	65–130	≤ 30
	Dibromochloromethane	75–131	≤ 20	65–131	≤ 30
	Dibromomethane	65-135	≤ 20	55-145	≤ 30
	Dichlorodifluoromethane	68–125	≤ 20	58–125	≤ 30
	EDB	75–131	≤ 20	65–131	≤ 30
	Ethylbenzene	71–129	≤ 20	61–129	≤ 30
	Hexachlorobutadiene	65-135	≤ 20	55-145	≤ 30

Table 7.2.3-2. Concluded

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8021B	Isopropylbenzene	65-135	≤ 20	55-145	≤ 30
	m-Xylene	65-135	≤ 20	55-145	≤ 30
	Methylene Chloride	42–176	≤ 20	32–176	≤ 30
	n-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	n-Propylbenzene	65-135	≤ 20	55-145	≤ 30
	Naphthalene	65-135	≤ 20	55-145	≤ 30
	o-Xylene	65-135	≤ 20	55-145	≤ 30
	p-Isopropyltoluene	65-135	≤ 20	55-145	≤ 30
	p-Xylene	65-135	≤ 20	55-145	≤ 30
	Sec-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	Styrene	65-135	≤ 20	55-145	≤ 30
	TCE	75–141	≤ 20	65–141	≤ 30
	Tert-Butylbenzene	65-135	≤ 20	55-145	≤ 30
	Tetrachloroethene	75–142	≤ 20	65–142	≤ 30
	Toluene	70–125	≤ 20	60–125	≤ 30
	Trans-1,2-DCE	75–130	≤ 20	68–130	≤ 30
	Trans-1,3-Dichloropropene	42–156	≤ 20	32–156	≤ 30
	Trichlorofluoromethane	75–130	≤ 20	69–130	≤ 30
	Vinyl Chloride	47–142	≤ 20	37–142	≤ 30
	Xylenes, Total	71–133	≤ 20	61–133	≤ 30
	Surrogates:				
	1,4-Dichlorobutane	35–135		35–135	
	Bromochlorobenzene	37–137		37–137	

Table 7.2.3-3. Summary of Calibration and QC Procedures for Method SW8021B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8021B	Aromatic and Halo-genated volatile organics	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value (for low boiling compounds, see footnote c)	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value (for low boiling compounds, see footnote c)	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.3-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8021B	Halogenated volatile organics	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.3-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.3-2	Reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.3-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.3-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8021B	Halogenated volatile organics	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.3-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.3-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.
c. Bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, trichlorofluoromethane and vinyl chloride may be within ±20% of expected value.

7.2.4 Method SW8070A-Nitrosamines

Select nitrosamines in water and soil samples are analyzed using method SW8070A. The sample is extracted and analyzed by gas chromatography. RLs for method SW8070A are presented in Table 7.2.4-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.4-2 and 7.2.4-3.

Table 7.2.4-1. RLs for Method SW8070A

		Water		Soil	
Parameter/Method	**Analyte**	**RL**	**Unit**	**RL**	**Unit**
Nitrosamines SW8070A	N-Nitrosodi-n-propylamine	2.0	µg/L	4.0	mg/kg
	N-Nitrosodimethylamine	0.50	µg/L	1.0	mg/kg
	N-Nitrosodiphenylamine	3.0	µg/L	6.0	mg/kg

Table 7.2.4-2. QC Acceptance Criteria for Method SW8070A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8070A	N-Nitrosodi-n-propylamine	45–146	≤ 30	35–146	≤ 50
	N-Nitrosodimethylamine	25–125	≤ 30	25–135	≤ 50
	N-Nitrosodiphenylamine	25–139	≤ 30	25–149	≤ 50
	Surrogates*[a]*:				

a. Use an analyte and its LCS limit from the method that is not expected to be present in the sample as the surrogate.

Table 7.2.4-3. Summary of Calibration and QC Procedures for Method SW8070A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8070A	Nitros-amines	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.4-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8070A	Nitros-amines	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.4-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.4-2	Reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.4-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.4-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8070A	Nitros-amines	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.4-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.4-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.5 Method SW8081A-Organochlorine Pesticides

Organochlorine pesticides in water and soil samples are analyzed using method SW8081A. This analytical method involves the extraction of the samples. The pesticides are then separated and quantified by GC using electron capture detection. Reporting limits (RLs) for this method are presented in Table 7.2.5-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.5-2 and 7.2.5-3.

A second-column confirmation is not required for the analysis of toxaphene or chlordane.

Table 7.2.5-1. RLs for Method SW8081A

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Organochlorine Pesticides SW8081A	α-BHC	0.35	µg/L	0.019	mg/kg
	β-BHC	0.23	µg/L	0.033	mg/kg
	δ-BHC	0.24	µg/L	0.011	mg/kg
	γ-BHC (Lindane)	0.25	µg/L	0.020	mg/kg
	α-Chlordane	0.80	µg/L	0.015	mg/kg
	γ-Chlordane	0.37	µg/L	0.015	mg/kg
	4,4'-DDD	0.50	µg/L	0.042	mg/kg
	4,4'-DDE	0.58	µg/L	0.025	mg/kg
	4,4'-DDT	0.81	µg/L	0.036	mg/kg
	Aldrin	0.34	µg/L	0.022	mg/kg
	Dieldrin	0.44	µg/L	0.035	mg/kg
	Endosulfan I	0.30	µg/L	0.021	mg/kg
	Endosulfan II	0.40	µg/L	0.024	mg/kg
	Endosulfan Sulfate	0.35	µg/L	0.036	mg/kg
	Endrin	0.39	µg/L	0.036	mg/kg
	Endrin Aldehyde	0.50	µg/L	0.016	mg/kg
	Heptachlor	0.40	µg/L	0.020	mg/kg
	Heptachlor Epoxide	0.32	µg/L	0.021	mg/kg
	Methoxychlor	0.86	µg/L	0.057	mg/kg
	Toxaphene	0.50	µg/L	0.57	mg/kg

Table 7.2.5-2. QC Acceptance Criteria for Method SW8081A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8081A	α-BHC	75–125	≤ 30	65–135	≤ 50
	β-BHC	51–125	≤ 30	41–133	≤ 50
	δ-BHC	75–126	≤ 30	65–136	≤ 50
	γ-BHC (Lindane)	73–125	≤ 30	63–130	≤ 50
	α-Chlordane	41–125	≤ 30	31–135	≤ 50
	γ-Chlordane	41–125	≤ 30	31–133	≤ 50
	4,4-DDD	48–136	≤ 30	38–146	≤ 50
	4,4-DDE	45–139	≤ 30	35–149	≤ 50
	4,4-DDT	34–143	≤ 30	25–153	≤ 50
	Aldrin	47–125	≤ 30	37–126	≤ 50
	Dieldrin	42–132	≤ 30	32–142	≤ 50
	Endosulfan I	49–143	≤ 30	39–153	≤ 50
	Endosulfan II	75–159	≤ 30	65–169	≤ 50
	Endosulfan Sulfate	46–141	≤ 30	36–151	≤ 50
	Endrin	43–134	≤ 30	33–144	≤ 50
	Endrin Aldehyde	75–150	≤ 30	65–160	≤ 50
	Heptachlor	45–128	≤ 30	35–138	≤ 50
	Heptachlor Epoxide	53–134	≤ 30	43–144	≤ 50
	Methoxychlor	73–142	≤ 30	63–152	≤ 50
	Toxaphene	41–126	≤ 30	31–136	≤ 50
	Surrogates:				
	DCBP	34–133		25–143	
	TCMX	45–125		35–135	

Table 7.2.5-3. Summary of Calibration and QC Procedures for Method SW8081A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8081A	Organo-chlorine pesticides	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification for all analytes	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.5-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8081A	Organo-chlorine pesticides	Breakdown check (Endrin and DDT)	Daily prior to analysis of samples	Degradation ≤15%	Repeat breakdown check	Apply J to all positive DDT, DDE, DDD, endrin, endrin ketone and endrin aldehyde results; apply R to the analytes listed above if minimum frequency is not met
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.5-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.5-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table 7.2.5-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8081A	Organo-chlorine pesticides	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.5-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.5-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation (excluding toxaphene and chlordane)	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.5-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.6 Method SW8082-Polychlorinated Biphenyls (PCBs)

PCBs in water and soil samples are analyzed using method SW8082. This analytical method involves the extraction of the samples. The PCBs are then separated and quantified by GC using electron capture detection or electrolytic conductivity detection. Practical quantitation limits (RLs) for this method are presented in Table 7.2.6-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.6-2 and 7.2.6-3.

For analysis of PCBs, the initial five-point calibration and second source calibration verification shall contain all PCBs. Retention times shall be verified for all analytes during the initial five point calibration. The daily calibration, initial calibration verification and the calibration verification may be done using only a mixture of PCB-1016 and PCB-1260. If a PCB is present (i.e., above the MDL), report the result of the PCB using the response factors from the initial five-point calibration. The LCS and MS/MSD may only be spiked with the 1016/1260 mix. A second-column confirmation is not required.

Table 7.2.6-1. RLs for Method SW8082

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
PCBs	PCB-1016	1.00	µg/L	0.70	mg/kg
	PCB-1221	1.00	µg/L	0.70	mg/kg
	PCB-1232	1.00	µg/L	0.70	mg/kg
	PCB-1242	1.00	µg/L	0.70	mg/kg
	PCB-1248	1.00	µg/L	0.70	mg/kg
	PCB-1254	1.00	µg/L	0.70	mg/kg
	PCB-1260	1.00	µg/L	0.70	mg/kg

Table 7.2.6-2. QC Acceptance Criteria for Method SW8082

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8082	PCB-1016	54–125	≤ 30	44–127	≤ 50
	PCB-1221	41–126	≤ 30	31–136	≤ 50
	PCB-1232	41–126	≤ 30	31–136	≤ 50
	PCB-1242	39–150	≤ 30	29–160	≤ 50
	PCB-1248	41–126	≤ 30	31–136	≤ 50
	PCB-1254	29–131	≤ 30	25–141	≤ 50
	PCB-1260	41–126	≤ 30	31–136	≤ 50
	Surrogate:				
	DCBP	34–133		25–143	

Table 7.2.6-3. Summary of Calibration and QC Procedures for Method SW8082

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8082	PCBs	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification for PCB 1016/1260 mix	Once per five-point initial calibration	Mix within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for PCB 1016/1260 mix	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification for PCB 1016/1260 mix	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification for PCB 1016/1260 mix	After every 20 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.6-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8082	PCBs	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.6-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS (1016/1260 mix)	One LCS per analytical batch	QC acceptance criteria, Table 7.2.6-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table 7.2.6-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8082	PCBs	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.6-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for the surrogate apply J to all positive results if the %R < LCL for the surrogate, apply J to all positive results, apply R to all non-detects If the surrogate recovery is < 10%, apply R to all results
		MS/MSD (1016/1260 mix)	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.6-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.6-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.7 Method SW8141A-Organophosphorus Pesticides

Method SW8141A is a GC method used to determine the concentrations of various organophosphorus pesticides. This analytical method involves extraction of the samples. An aliquot of the extract is injected into a GC and compounds in the GC effluent are detected with a flame photometric or nitrogen-phosphorus detector. Any compounds identified tentatively in the primary analysis are confirmed on a second GC column. RLs for these pesticides are presented in Table 7.2.7-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.7-2 and 7.2.7-3.

Table 7.2.7-1. RLs for Method SW8141A

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Organophosphorus Pesticides SW8141A	Azinphos Methyl	1.0	µg/L	0.05	mg/kg
	Bolstar	0.7	µg/L	0.04	mg/kg
	Chlorpyrifos	0.7	µg/L	0.05	mg/kg
	Coumaphos	2.0	µg/L	0.10	mg/kg
	Demeton-o	1.2	µg/L	0.06	mg/kg
	Demeton-s	1.2	µg/L	0.06	mg/kg
	Diazinon	2.0	µg/L	0.10	mg/kg
	Dichlorovos	8.0	µg/L	0.40	mg/kg
	Disulfoton	0.7	µg/L	0.04	mg/kg
	Ethoprop	2.0	µg/L	0.10	mg/kg
	Fensulfothion	0.8	µg/L	0.04	mg/kg
	Fenthion	0.8	µg/L	0.05	mg/kg
	Merphos	2.0	µg/L	0.10	mg/kg
	Mevinphos	5.0	µg/L	0.25	mg/kg
	Naled	5.0	µg/L	0.25	mg/kg
	Parathion Methyl	1.2	µg/L	0.06	mg/kg
	Phorate	0.4	µg/L	0.02	mg/kg
	Ronnel	0.7	µg/L	0.04	mg/kg
	Stirophos	8.0	µg/L	0.40	mg/kg
	Tokuthion	0.7	µg/L	0.06	mg/kg
	Trichloronate	8.0	µg/L	0.40	mg/kg

Table 7.2.7-2. QC Acceptance Criteria for Method SW8141A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8141A	Azinphos Methyl	50–150	≤ 30	40–160	≤ 50
	Bolstar	46–125	≤ 30	36–135	≤ 50
	Chlorpyrifos	75–125	≤ 30	65–135	≤ 50
	Coumaphos	71–147	≤ 30	61–157	≤ 50
	Demeton-o	50–150	≤ 30	40–160	≤ 50
	Demeton-s	50–150	≤ 30	40–160	≤ 50
	Diazinon	47–149	≤ 30	37–159	≤ 50
	Dichlorovos	49–125	≤ 30	39–135	≤ 50
	Disulfoton	50–150	≤ 30	40–160	≤ 50
	Ethoprop	75–125	≤ 30	65–135	≤ 50
	Fensulfothion	43–145	≤ 30	33–155	≤ 50
	Fenthion	25–125	≤ 30	25–135	≤ 50
	Merphos	75–144	≤ 30	65–154	≤ 50
	Mevinphos	33–125	≤ 30	25–135	≤ 50
	Naled	54–125	≤ 30	44–135	≤ 50
	Parathion Methyl	45–130	≤ 30	35–140	≤ 50
	Phorate	50–150	≤ 30	40–160	≤ 50
	Ronnel	75–125	≤ 30	65–135	≤ 50
	Stirophos	48–125	≤ 30	38–135	≤ 50
	Tokuthion	44–125	≤ 30	34–135	≤ 50
	Trichloronate	49–161	≤ 30	39–171	≤ 50
	Surrogates:				
	Tributyl Phosphate	67-136		57-146	
	Triphenyl Phosphate	65-134		55-144	

Table 7.2.7-3. Summary of Calibration and QC Procedures for Method SW8141A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8141A	Organophos-phorus pesticides	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.7-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8141A	Organophos-phorus pesticides	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.7-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.7-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table 7.2.7-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8141A	Organophos-phorus pesticides	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.7-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.7-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.7-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.8 Method SW8151A-Chlorinated Herbicides

Method SW8151A is a capillary GC method for determining selected chlorinated acid herbicides and related compounds. Samples are extracted then esterified. The esters are determined by GC employing an electron capture detector. Any compounds identified tentatively in the primary analysis are confirmed on a second GC column. RLs for herbicides are presented in Table 7.2.8-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.8-2 and 7.2.8-3.

Table 7.2.8-1. RLs for Method SW8151A

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Chlorinated Phenoxy Acid Herbicides SW8151A	2,4-D	2.0	µg/L	0.001	mg/kg
	2,4-DB	8.0	µg/L	10.0	mg/kg
	2,4,5-T	0.80	µg/L	0.5	mg/kg
	2,4,5-TP	0.75	µg/L	0.003	mg/kg
	Dalapon	13.0	µg/L	0.01	mg/kg
	Dicamba	0.81	µg/L	0.5	mg/kg
	Dichloroprop	2.6	µg/L	2.0	mg/kg
	Dinoseb	1.9	µg/L	2.7	mg/kg
	MCPA	0.56	µg/L	0.43	mg/kg
	MCPP	0.9	µg/L	0.66	mg/kg

Table 7.2.8-2. QC Acceptance Criteria for Method SW8151A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8151A	2,4-D	65–125	≤ 30	55–135	≤ 50
	2,4-DB	65–125	≤ 30	55–135	≤ 50
	2,4,5-T	71–125	≤ 30	61–135	≤ 50
	2,4,5-TP	75–125	≤ 30	65–135	≤ 50
	Dalapon	70–125	≤ 30	60–135	≤ 50
	Dicamba	59–125	≤ 30	49–135	≤ 50
	Dichloroprop	63–125	≤ 30	53–135	≤ 50
	Dinoseb	72–125	≤ 30	62–135	≤ 50
	MCPA	64–125	≤ 30	54–135	≤ 50
	MCPP	75–125	≤ 30	65–135	≤ 50
	Surrogate:				
	2,4-Dichlorophenylacetic acid	61-136		51-146	

Table 7.2.8-3. Summary of Calibration and QC Procedures for Method SW8151A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8151A	Chlorinated Herbicides	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD for all analytes ≤20% with no individual analyte RSD >30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.8-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8151A	Chlorinated Herbicides	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.8-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.8-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.8-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.8-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8151A	Chlorinated Herbicides	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.8-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Second-column confirmation	100% for all positive results	Same as for initial or primary column analysis	Same as for initial or primary column analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first column result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.8-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.9 Method SW8260B-Volatile Organics

Volatile (or purgeable) organics in water and soil samples are analyzed using method SW8260B. This method uses a capillary column GC/mass spectrometry technique. Volatile compounds are introduced into the GC by purge and trap (SW5030B). An inert gas is bubbled through the water samples (or a soil-water slurry for soil samples) to transfer the purgeable organic compounds from the liquid to vapor phase. Soil samples with higher contaminant levels are extracted using methanol before purging. The vapor is then swept through a sorbent trap where the purgeable organics are trapped. The trap is backflushed and heated to desorb the purgeable organics onto a capillary GC column where they are separated and then detected with a mass spectrometer. The analytes detected and RLs (using a 25 mL purge) for this method are listed in Table 7.2.9-1.

Calibration—The mass spectrometer is tuned daily to give an acceptable spectrum for BFB. The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 50 15 percent to 40 percent of mass 95
- mass 75 30 percent to 60 percent of mass 95
- mass 95 base peak, 100 percent relative abundance
- mass 96 5 percent to 9 percent of mass 95
- mass 173 less than 2 percent of mass 174
- mass 174 greater than 50 percent of mass 95
- mass 175 5 percent to 9 percent of mass 174
- mass 176 greater than 95 percent, but less than 101 percent of mass 174
- mass 177 5 percent to 9 percent of mass 176

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS added to each calibration standard, blank, QC sample, and sample. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.9-2 and 7.2.9-3.

Table 7.2.9-1. RLs for Method SW8260B

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
VOCs	1,1,1,2-Tetrachloroethane	0.5	µg/L	0.003	mg/kg
SW8260B	1,1,1-TCA	0.8	µg/L	0.004	mg/kg
	1,1,2,2-Tetrachloroethane	0.4	µg/L	0.002	mg/kg
	1,1,2-TCA	1.0	µg/L	0.005	mg/kg
	1,1-DCA	0.4	µg/L	0.002	mg/kg
	1,1-DCE	1.2	µg/L	0.006	mg/kg
	1,1-Dichloropropene	1.0	µg/L	0.005	mg/kg
	1,2,3-Trichlorobenzene	0.3	µg/L	0.002	mg/kg
	1,2,3-Trichloropropane	3.2	µg/L	0.02	mg/kg
	1,2,4-Trichlorobenzene	0.4	µg/L	0.002	mg/kg
	1,2,4-Trimethylbenzene	1.3	µg/L	0.007	mg/kg
	1,2-DCA	0.6	µg/L	0.003	mg/kg
	1,2-DCB	0.3	µg/L	0.002	mg/kg
	1,2-Dibromo-3-chloropropane	2.6	µg/L	0.01	mg/kg
	1,2-Dichloropropane	0.4	µg/L	0.002	mg/kg
	1,2-EDB	0.6	µg/L	0.003	mg/kg
	1,3,5-Trimethylbenzene	0.5	µg/L	0.003	mg/kg
	1,3-DCB	1.2	µg/L	0.006	mg/kg
	1,3-Dichloropropane	0.4	µg/L	0.002	mg/kg
	1,4-DCB	0.3	µg/L	0.002	mg/kg
	1-Chlorohexane	0.5	µg/L	0.003	mg/kg
	2,2-Dichloropropane	3.5	µg/L	0.02	mg/kg
	2-Chlorotoluene	0.4	µg/L	0.002	mg/kg
	4-Chlorotoluene	0.6	µg/L	0.003	mg/kg
	Benzene	0.4	µg/L	0.002	mg/kg
	Bromobenzene	0.3	µg/L	0.002	mg/kg
	Bromochloromethane	0.4	µg/L	0.002	mg/kg
	Bromodichloromethane	0.8	µg/L	0.004	mg/kg
	Bromoform	1.2	µg/L	0.006	mg/kg
	Bromomethane	1.1	µg/L	0.005	mg/kg
	Carbon tetrachloride	2.1	µg/L	0.01	mg/kg
	Chlorobenzene	0.4	µg/L	0.002	mg/kg
	Chloroethane	1.0	µg/L	0.005	mg/kg
	Chloroform	0.3	µg/L	0.002	mg/kg
	Chloromethane	1.3	µg/L	0.007	mg/kg
	Cis-1,2-DCE	1.2	µg/L	0.006	mg/kg
	Cis-1,3-Dichloropropene	1.0	µg/L	0.005	mg/kg
	Dibromochloromethane	0.5	µg/L	0.003	mg/kg
	Dibromomethane	2.4	µg/L	0.01	mg/kg
	Dichlorodifluoromethane	1.0	µg/L	0.005	mg/kg
	Ethylbenzene	0.6	µg/L	0.003	mg/kg
	Hexachlorobutadiene	1.1	µg/L	0.005	mg/kg

Table 7.2.9-1. Concluded

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
VOCs	Isopropylbenzene	0.5	µg/L	0.008	mg/kg
SW8260B	m-Xylene	0.5	µg/L	0.003	mg/kg
(concluded)	Methylene chloride	0.3	µg/L	0.002	mg/kg
	n-Butylbenzene	1.1	µg/L	0.005	mg/kg
	n-Propylbenzene	0.4	µg/L	0.002	mg/kg
	Naphthalene	0.4	µg/L	0.002	mg/kg
	o-Xylene	1.1	µg/L	0.005	mg/kg
	p-Isopropyltoluene	1.2	µg/L	0.006	mg/kg
	p-Xylene	1.3	µg/L	0.007	mg/kg
	Sec-Butylbenzene	1.3	µg/L	0.007	mg/kg
	Styrene	0.4	µg/L	0.002	mg/kg
	TCE	1.0	µg/L	0.01	mg/kg
	Tert-Butylbenzene	1.4	µg/L	0.007	mg/kg
	Tetrachloroethene	1.4	µg/L	0.007	mg/kg
	Toluene	1.1	µg/L	0.005	mg/kg
	Trans-1,2-DCE	0.6	µg/L	0.003	mg/kg
	Trans-1,3-Dichloropropene	1.0	µg/L	0.005	mg/kg
	Trichlorofluoromethane	0.8	µg/L	0.004	mg/kg
	Vinyl chloride	1.1	µg/L	0.009	mg/kg

Table 7.2.9-2. QC Acceptance Criteria for Method SW8260B

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Assoc. IS
SW8260B	1,1,1,2-Tetrachloroethane	72–125	≤ 20	62–108	≤ 30	2
	1,1,1-TCA	75–125	≤ 20	65–135	≤ 30	1
	1,1,2,2-Tetrachloroethane	74–125	≤ 20	64–135	≤ 30	3
	1,1,2-TCA	75–127	≤ 20	65–135	≤ 30	1
	1,1-DCA	72–125	≤ 20	62–135	≤ 30	1
	1,1-DCE	75–125	≤ 20	65–135	≤ 30	1
	1,1-Dichloropropene	75–125	≤ 20	65–135	≤ 30	1
	1,2,3-Trichlorobenzene	75–137	≤ 20	65–147	≤ 30	3
	1,2,3-Trichloropropane	75–125	≤ 20	65–135	≤ 30	3
	1,2,4-Trichlorobenzene	75–135	≤ 20	65–145	≤ 30	3
	1,2,4-Trimethylbenzene	75-125	≤ 20	65–135	≤ 30	3
	1,2-DCA	68–127	≤ 20	58–137	≤ 30	1
	1,2-DCB	75-125	≤ 20	65–135	≤ 30	3
	1,2-Dibromo-3-chloropropane	59–125	≤ 20	49–135	≤ 30	3
	1,2-Dichloropropane	70–125	≤ 20	60–135	≤ 30	1
	1,2-EDB	75-125	≤ 20	65–135	≤ 30	2
	1,3,5-Trimethylbenzene	72–112	≤ 20	62–135	≤ 30	3
	1,3-DCB	75-125	≤ 20	65–135	≤ 30	3
	1,3-Dichloropropane	75-125	≤ 20	65–135	≤ 30	2
	1,4-DCB	75-125	≤ 20	65–135	≤ 30	3
	1-Chlorohexane	75-125	≤ 20	65–135	≤ 30	2
	2,2-Dichloropropane	75-125	≤ 20	65–135	≤ 30	1
	2-Chlorotoluene	73–125	≤ 20	63–135	≤ 30	3
	4-Chlorotoluene	74–125	≤ 20	64–135	≤ 30	3
	Benzene	75–125	≤ 20	65–135	≤ 30	1
	Bromobenzene	75–125	≤ 20	65–135	≤ 30	3
	Bromochloromethane	73–125	≤ 20	63–135	≤ 30	1
	Bromodichloromethane	75–125	≤ 20	65–135	≤ 30	1
	Bromoform	75–125	≤ 20	65–135	≤ 30	2
	Bromomethane	72–125	≤ 20	62–135	≤ 30	1
	Carbon Tetrachloride	62–125	≤ 20	52–135	≤ 30	1
	Chlorobenzene	75–125	≤ 20	65–135	≤ 30	2
	Chloroethane	65–125	≤ 20	55–135	≤ 30	1
	Chloroform	74–125	≤ 20	64–135	≤ 30	1
	Chloromethane	75-125	≤ 20	65–135	≤ 30	1
	Cis-1,2-DCE	75–125	≤ 20	65–135	≤ 30	1
	Cis-1,3-Dichloropropene	74–125	≤ 20	64–135	≤ 30	1
	Dibromochloromethane	73–125	≤ 20	63–135	≤ 30	2
	Dibromomethane	69–127	≤ 20	59–137	≤ 30	1
	Dichlorodifluoromethane	75-125	≤ 20	65–135	≤ 30	1

Table 7.2.9-2. Concluded

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Assoc. IS
SW8260B (Concluded)	Ethylbenzene	75–125	≤ 20	65–135	≤ 30	2
	Hexachlorobutadiene	75–125	≤ 20	65–135	≤ 30	3
	Isopropylbenzene	75–125	≤ 20	65–135	≤ 30	3
	m-Xylene	75–125	≤ 20	65–135	≤ 30	2
	Methylene chloride	75–125	≤ 20	65–135	≤ 30	1
	n-Butylbenzene	75–125	≤ 20	65–135	≤ 30	3
	n-Propylbenzene	75–125	≤ 20	65–135	≤ 30	3
	Naphthalene	75–125	≤ 20	65–135	≤ 30	3
	o-Xylene	75–125	≤ 20	65–135	≤ 30	2
	p-Isopropyltoluene	75–125	≤ 20	65–135	≤ 30	3
	p-Xylene	75–125	≤ 20	65–135	≤ 30	2
	Sec-Butylbenzene	75–125	≤ 20	65–135	≤ 30	3
	Styrene	75–125	≤ 20	65–135	≤ 30	2
	TCE	71–125	≤ 20	61–135	≤ 30	1
	Tert-butylbenzene	75-125	≤ 20	65–135	≤ 30	3
	Tetrachloroethene	71–125	≤ 20	61–135	≤ 30	2
	Toluene	74–125	≤ 20	64–135	≤ 30	1
	Trans-1,2-DCE	75–125	≤ 20	65–135	≤ 30	1
	Trans-1,3-Dichloropropene	66–125	≤ 20	56–135	≤ 30	1
	Trichlorofluoromethane	67–125	≤ 20	57–135	≤ 30	1
	Vinyl Chloride	46–134	≤ 20	36–144	≤ 30	1
	Surrogates:					
	Dibromofluoromethane	75–125		65–135		
	Toluene-D8	75–125		65–135		
	4-Bromofluorobenzene	75–125		65–135		
	1,2-DCA-D4	62–139		52–149		
	Internal Standards:					
	Fluorobenzene					1
	Chlorobenzene-D5					2
	1,4-Dichlorobenzend-D					3

Table 7.2.9-3. Summary of Calibration and QC Procedures for Method SW8260B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8260B	Volatile Organics	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥ 0.30[c] and %RSD for RFs for CCCs ≤ 30% and one option below	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration
				option 1 linear- mean RSD for all analytes ≤15% with no individual analyte RSD >30%		Apply R to all results for specific analyte(s) for all samples associated with the calibration
				option 2 linear – least squares regression r > 0.995		
				option 3 non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±25% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each sample	Relative retention time (RRT) of the analyte within ± 0.06 RRT units of the RRT	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Calibration verification	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.30[c]; and CCCs ≤ 20% difference (when using RFs)or drift (when using least squares regression or non-linear calibration)	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration verification
				All calibration analytes within ±20% of expected value		Apply R to all results for specific analyte(s) for all samples associated with the calibration verification

Table 7.2.9-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8260B	Volatile Organics	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.9-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		ISs	Immediately after or during data acquisition for each sample	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Apply R to all results for analytes associated with the IS
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.9-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.9-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or(2)%R for MS or MSD < LCL or (3) MS/MSD RPD > CL

Table 7.2.9-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8260B	Volatile Organics	Check of mass spectral ion intensities using BFB	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description (section 7.2.9)	Retune instrument and verify	Apply R to all results for all samples associated with the tune
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.9-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for a surrogate, apply J to all positive results if the %R < LCL for a surrogate, apply J to all positive results; apply R to all non-detect results If any surrogate recovery is <10%, apply R to all results
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.9-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.
c. Except > 0.10 for bromoform, and > 0.10 for chloromethane and 1,1-dichloroethane

7.2.10 Method SW8270C-Semivolatile Organics

Semivolatile organics (also known as base/neutral and acid extractables) in water and soil samples are analyzed using method SW8270C. This technique determines quantitatively the concentration of a number of SVOCs. Samples are extracted and both base/neutral and acid extracts are then concentrated through evaporation. Compounds of interest are separated and quantified using a capillary column GC/mass spectrometer. The RLs are listed in Table 7.2.10-1.

The mass spectrometer is tuned every 12 hours to give an acceptable spectrum for decafluorotriphenylphosphine (DFTPP). The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 51-30 percent to 60 percent of mass 198
- mass 68 less than 2 percent of mass 69
- mass 70 less than 2 percent of mass 69
- mass 127 40 percent to 60 percent of mass 198
- mass 197 less than 1 percent of mass 198
- mass 198 base peak, 100 percent relative abundance
- mass 199 5 percent to 9 percent of mass 198
- mass 275 10 percent to 30 percent of mass 198
- mass 365 greater than 1 percent of mass 198
- mass 441 present, but less than mass 443
- mass 442 greater than 40 percent of mass 198
- mass 443 17 percent to 23 percent of mass 442

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS that is added to each calibration standard, blank, QC sample, and sample. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.10-2 and 7.2.10-3.

Table 7.2.10-1. RLs for Method SW8270C

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Semivolatile organics Base/Neutral Extractables SW8270C	1,2,4-Trichlorobenzene	10.0	µg/L	0.7	mg/kg
	1,2-DCB	10.0	µg/L	0.7	mg/kg
	1,3-DCB	10.0	µg/L	0.7	mg/kg
	1,4-DCB	10.0	µg/L	0.7	mg/kg
	2,4-DNT	10.0	µg/L	0.7	mg/kg
	2,6-DNT	10.0	µg/L	0.7	mg/kg
	2-Chloronaphthalene	10.0	µg/L	0.7	mg/kg
	2-Methylnaphthalene	10.0	µg/L	0.7	mg/kg
	2-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3-Nitroaniline	50.0	µg/L	3.3	mg/kg
	3,3'-Dichlorobenzidine	20.0	µg/L	1.3	mg/kg
	4-Bromophenyl phenyl ether	10.0	µg/L	0.7	mg/kg
	4-Chloroaniline	20.0	µg/L	1.3	mg/kg
	4-Chlorophenyl phenyl ether	10.0	µg/L	0.7	mg/kg
	4-Nitroaniline	50.0	µg/L	3.3	mg/kg
	Acenaphthylene	10.0	µg/L	0.7	mg/kg
	Acenapthene	10.0	µg/L	0.7	mg/kg
	Anthracene	10.0	µg/L	0.7	mg/kg
	Benz (a) anthracene	10.0	µg/L	0.7	mg/kg
	Benzo (a) pyrene	10.0	µg/L	0.7	mg/kg
	Benzo (b) fluoranthene	10.0	µg/L	0.7	mg/kg
	Benzo (g,h,i) perylene	10.0	µg/L	0.7	mg/kg
	Benzyl alcohol	20.0	µg/L	1.3	mg/kg
	Bis (2-chloroethoxy) methane	10.0	µg/L	0.7	mg/kg
	Bis (2-chlorethyl) ether	10.0	µg/L	0.7	mg/kg
	Bis (2-chloroisopropyl) ether	10.0	µg/L	0.7	mg/kg
	Bis (2-ethylhexyl) phthalate	10.0	µg/L	0.7	mg/kg
	Butyl benzylphthalate	10.0	µg/L	0.7	mg/kg
	Chrysene	10.0	µg/L	0.7	mg/kg
	Di-n-butylphthalate	10.0	µg/L	0.7	mg/kg
	Di-n-octylphthalate	10.0	µg/L	0.7	mg/kg
	Dibenz (a,h) anthracene	10.0	µg/L	0.7	mg/kg
	Dibenzofuran	10.0	µg/L	0.7	mg/kg
	Diethyl phthalate	10.0	µg/L	0.7	mg/kg
	Dimethly phthalate	10.0	µg/L	0.7	mg/kg
	Fluoranthene	10.0	µg/L	0.7	mg/kg
	Fluorene	10.0	µg/L	0.7	mg/kg
	Hexachlorobenzene	10.0	µg/L	0.7	mg/kg
	Hexachlorobutadiene	10.0	µg/L	0.7	mg/kg
	Hexachlorocyclopentadiene	10.0	µg/L	0.7	mg/kg
	Hexachloroethane	10.0	µg/L	0.7	mg/kg
	Indeno (1,2,3-cd) pyrene	10.0	µg/L	0.7	mg/kg
	Isophorone	10.0	µg/L	0.7	mg/kg

Table 7.2.10-1. Concluded

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Semivolatile organics Base/Neutral Extractables SW8270C (concluded)	n-Nitrosodiphenylamine	10.0	µg/L	0.7	mg/kg
	n-Nitrosodi-n-propylamine	10.0	µg/L	0.7	mg/kg
	Naphthalene	10.0	µg/L	0.7	mg/kg
	Nitrobenzene	10.0	µg/L	0.7	mg/kg
	Phenanthrene	10.0	µg/L	0.7	mg/kg
	Pyrene	10.0	µg/L	0.7	mg/kg
Semivolatile organics Acid Extractables SW8270C	2,4,5-Trichlorophenol	50.0	µg/L	3.3	mg/kg
	2,4,6-Trichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dichlorophenol	10.0	µg/L	0.3	mg/kg
	2,4-Dimethylphenol	10.0	µg/L	0.3	mg/kg
	2,4-Dinitrophenol	50.0	µg/L	3.3	mg/kg
	2-Chlorophenol	10.0	µg/L	0.3	mg/kg
	2-Methylphenol	10.0	µg/L	0.3	mg/kg
	2-Nitrophenol	10.0	µg/L	0.3	mg/kg
	4,6-Dinitro-2-methylphenol	50.0	µg/L	3.3	mg/kg
	4-Chloro-3-methylphenol	20.0	µg/L	1.3	mg/kg
	4-Methylphenol	10.0	µg/L	0.3	mg/kg
	4-Nitrophenol	50.0	µg/L	1.6	mg/kg
	Benzoic acid	50.0	µg/L	1.6	mg/kg
	Pentachlorophenol	50.0	µg/L	3.3	mg/kg
	Phenol	10.0	µg/L	0.3	mg/kg

Table 7.2.10-2. QC Acceptance Criteria for Method SW8270C

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Assoc. IS	Assoc. Sur.
SW8270C	1,2,4-Trichlorobenzene	44–142	≤ 20	34–152	≤ 30	2	4
	1,2-DCB	42–155	≤ 20	32–135	≤ 30	1	3
	1,3-DCB	36–125	≤ 20	26–135	≤ 30	1	3
	1,4-DCB	30–125	≤ 20	25–135	≤ 30	1	3
	2,4-DNT	39–139	≤ 20	29–149	≤ 30	3	4
	2,6-DNT	51–125	≤ 20	41–135	≤ 30	3	4
	2-Chloronaphthalene	60–125	≤ 20	50–135	≤ 30	3	4
	2-Methylnaphthalene	41–125	≤ 20	31–135	≤ 30	2	5
	2-Nitroaniline	50–125	≤ 20	40–135	≤ 30	3	2
	3,3'-Dichlorobenzidine	29–175	≤ 20	25–175	≤ 30	5	6
	3-Nitroaniline	51–125	≤ 20	41–135	≤ 30	3	2
	4-Bromophenyl phenyl ether	53–127	≤ 20	43–137	≤ 30	4	1
	4-Chloroaniline	45-136	≤ 20	35-146	≤ 30	2	5
	4-Chlorophenyl phenyl ether	51–132	≤ 20	41–142	≤ 30	3	4
	4-Nitroaniline	40–143	≤ 20	30–153	≤ 30	3	2
	Acenaphthylene	47–125	≤ 20	37–135	≤ 30	3	4
	Acenaphthene	49–125	≤ 20	39–135	≤ 30	3	4
	Anthracene	45–165	≤ 20	35–175	≤ 30	4	1
	Benz (a) anthracene	51–133	≤ 20	41–143	≤ 30	5	6
	Benzo (a) pyrene	41–125	≤ 20	31–135	≤ 30	6	6
	Benzo (b) fluoranthene	37–125	≤ 20	27–1 35	≤ 30	6	6
	Benzo (g,h,i) perylene	34–149	≤ 20	25–159	≤ 30	6	6
	Benzyl alcohol	35–125	≤ 20	25–135	≤ 30	1	3
	Bis (2-chloroethoxy) methane	49–125	≤ 20	39–135	≤ 30	2	5
	Bis (2-chloroethyl) ether	44–125	≤ 20	34–135	≤ 30	1	3
	Bis (2-chloroisopropyl) ether	36–166	≤ 20	26–175	≤ 30	1	3
	Bis (2-ethylhexyl) phthalate	33–129	≤ 20	25–139	≤ 30	5	6
	Butyl benzyl phthalate	26–125	≤ 20	25–135	≤ 30	5	6
	Chrysene	55–133	≤ 20	45–143	≤ 30	5	6
	Di-n-butyl phthalate	34–126	≤ 20	25–136	≤ 30	4	1
	Di-n-octyl phthalate	38–127	≤ 20	28–137	≤ 30	5	6
	Dibenz (a,h) anthracene	50–125	≤ 20	40–135	≤ 30	6	6
	Dibenzofuran	52–125	≤ 20	42–135	≤ 30	3	4
	Diethyl phthalate	37–125	≤ 20	27–135	≤ 30	3	4
	Dimethyl phthalate	25–175	≤ 20	25–175	≤ 30	3	4
	Fluoranthene	47–125	≤ 20	37–135	≤ 30	4	1
	Fluorene	48–139	≤ 20	38–149	≤ 30	3	2

Table 7.2.10-2. Continued

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Assoc. IS	Assoc. Sur.
SW8270C (Continued)	Hexachlorobenzene	46–133	≤ 20	36–143	≤ 30	4	1
	Hexachlorobutadiene	25–125	≤ 20	25–135	≤ 30	2	5
	Hexachlorocyclopentadiene	41–125	≤ 20	31–135	≤ 30	3	2
	Hexachloroethane	25–153	≤ 20	25–163	≤ 30	1	3
	Indeno (1,2,3-c,d) pyrene	27–160	≤ 20	25–170	≤ 30	5	6
	Isophorone	26–175	≤ 20	25–175	≤ 30	2	5
	n-Nitrosodi-n-propylamine	37–125	≤ 20	27–135	≤ 30	1	3
	n-Nitrosodiphenylamine	27–125	≤ 20	25–135	≤ 30	4	1
	Naphthalene	50–125	≤ 20	40–135	≤ 30	2	5
	Nitrobenzene	46–133	≤ 20	36–143	≤ 30	2	4
	Phenanthrene	54–125	≤ 20	44–135	≤ 30	4	1
	Pyrene	47–136	≤ 20	37–146	≤ 30	5	6
	2,4,5-Trichlorophenol	25–175	≤ 20	25–175	≤ 30	3	1
	2,4,6-Trichlorophenol	39–128	≤ 20	29–138	≤ 30	3	1
	2,4-Dichlorophenol	46–125	≤ 20	36–135	≤ 30	2	5
	2,4-Dimethylphenol	45–139	≤ 20	35–149	≤ 30	2	5
	2,4-Dinitrophenol	30–151	≤ 20	25–161	≤ 30	3	4
	2-Chlorophenol	41–125	≤ 20	31–135	≤ 30	1	3
	2-Methylphenol	25–125	≤ 20	25–135	≤ 30	1	3
	2-Nitrophenol	44–125	≤ 20	34–135	≤ 30	2	4
	4,6-Dinitro-2-Methyl Phenol	26–134	≤ 20	25–144	≤ 30	4	1
	4-Chloro-3-Methyl Phenol	44–125	≤ 20	34–135	≤ 30	2	5
	4-Methylphenol	33–125	≤ 20	25–135	≤ 30	1	3
	4-Nitrophenol	25–131	≤ 20	25–141	≤ 30	3	2
	Benzoic Acid	25–162	≤ 20	25–172	≤ 30	2	5
	Pentachlorophenol	28–136	≤ 20	38–146	≤ 30	4	1
	Phenol	25–125	≤ 20	25–135	≤ 30	1	5

Table 7.2.10-2. Concluded

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)	Number
SW8270C	***Surrogates:***					
(Concluded)	2,4,6-Tribromophenol	25–134		25–144		1
	2-Fluorobiphenyl	43–125		34–135		2
	2-Fluorophenol	25–125		25–135		3
	Nitrobenzene-D5	32–125		25–135		4
	Phenol-D5	25–125		25–135		5
	Terphenyl-D14	42–126		32–136		6
	Internal Standards:					
	1,4-Dichlorobenzene-D4					1
	Naphthalene-D8					2
	Acenaphthalene-D8					3
	Phenanthrene-D10					4
	Chrysene-D12					5
	Perylene-D12					6

Table 7.2.10-3. Summary of Calibration and QC Procedures for Method SW8270C

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8270C	Volatile Organics	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥ 0.050 and %RSD for RFs for CCCs ≤ 30% and one option below	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration
				option 1 linear- mean RSD for all analytes ≤15% with no individual analyte RSD >30%		Apply R to all results for specific analyte(s) for all samples associated with the calibration
				option 2 linear – least squares regression r > 0.995		
				option 3 non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±25% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each sample	Relative retention time (RRT) of the analyte within ± 0.06 RRT units of the RRT	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Calibration verification	Daily, before sample analysis and every 12 hours of analysis time	SPCCs average RF ≥ 0.050; and CCCs ≤ 20% difference (when using RFs)or drift (when using least squares regression or non-linear calibration)	Correct problem then repeat initial calibration	Apply R to all results for all samples associated with the calibration verification
				All calibration analytes within ±20% of expected value		Apply R to all results for specific analyte(s) for all samples associated with the calibration verification

Table 7.2.10-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8270C	Volatile Organics	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.10-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		ISs	Immediately after or during data acquisition for each sample	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Apply R to all results for analytes associated with the IS
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.10-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.10-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or(2)%R for MS or MSD < LCL or (3) MS/MSD RPD > CL

Table 7.2.10-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8270C	Volatile Organics	Check of mass spectral ion intensities using DFTPP	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description (section 7.2.10)	Retune instrument and verify	Apply R to all results for all samples associated with the tune
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.10-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for a surrogate, apply J to all positive results of analytes associated with the surrogate if the %R < LCL for a surrogate, apply J to all positive results of analytes associated with the surrogate, apply R to all non-detect results of analytes associated with the surrogate If any surrogate recovery is < 10%, apply R to all results of analytes associated with the surrogate
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.10-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.11 Method SW8280A-Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans

Method SW8280A is used to analyze for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in water, soil, and waste. This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/low resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte. Because of the extreme toxicity of these compounds, the analyst must take appropriate precautions during preparation and analysis to prevent accidental exposure. RLs are presented in Table 7.2.11-1.

A tetrachlorinated dibenzo-p-dioxin (TCDD) chromatographic test mixture is analyzed daily to verify that there is at least 25 percent valley resolution between 2,3,7,8 TCDD and 1,2,3,4 TCDD. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.11-2 and 7.2.11-3.

Table 7.2.11-1. RLs for Method SW8280A

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Dioxins and Furans	2,3,7,8-TCDD	4.4	ng/L	1.7	µg/kg
SW8280A	2,3,7,8-TCDF	1.0	ng/L	1.1	µg/kg

Table 7.2.11-2. QC Acceptance Criteria for Method SW8280A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8280A	2,3,7,8-TCDD	50–140	≤ 30	56–140	≤ 50
	2,3,7,8-TCDF	50–140	≤ 30	50–140	≤ 50
	Surrogates:				
	C13-2,3,7,8-TCDF	40–125		30–135	
	C13-2,3,7,8-TCDD	40–125		30–135	

Table 7.2.11-3. Summary of Calibration and QC Procedures for Method SW8280A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8280A	Dioxins/ Furans	Check mass spectral ion intensity	Prior to each initial calibration	See footnote c	Retune instrument; verify	Apply R to all results associated with the tune
		Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	RSD ≤15% for CFs or RFs	Correct problem then repeat initial calibration	Apply R to the result for the specific analyte(s) for all samples associated with the calibration
		Retention time window	Prior to calibration	Per method SW8280A, Section 7.1	Per method SW8280A, Section 7.1	Apply R to the result for the specific analyte(s) in the sample
		Column performance check	Prior to sample analysis, at the beginning of every 12-hour period, and at the end of the final run period	A ≤ 25% valley between 1,2,3,4-TCDD and 2,3,7,8-TCDD	Correct problem then repeat until criteria are met	Apply R to all tetra isomers if valley is > 25%
		Calibration verification (500 ng/mL standard)	As part of initial calibration and at the beginning of each 12-hour period	RF within 30% (RPD) of average initial multipoint RF; isotope ratios in agreement with footnote c	Correct problem then repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification	Apply R to the result for the specific analyte(s) for all samples associated with the calibration
		Sensitivity check (200 ng/mL standard)	As part of initial calibration and at the beginning of each 12-hour period	S/N for 2,3,7,8-TCDD standard ≥ 50:1	Correct problem then repeat initial calibration and reanalyze all samples analyzed since the last successful sensitivity check	Apply R to all analytes if S/N is ≤ 50:1

Table 7.2.11-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8280A	Dioxins/ Furans	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.11-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to the specific analyte(s) result for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ MDL for the analyte or ≥5% of the associated regulatory limit for the analyte or ≥5% of the sample result for the analyte whichever is greater	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to the result for specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.11-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table 7.2.11-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8280A	Dioxins/ Furans	Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.11-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.11-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.11-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed

Table 7.2.11-3 Concluded.

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8280A	Dioxins/ Furans	Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.
c. The acceptance criteria for spectral ion intensities are given below:

PCDDs	Selected Ions (m/z)	Relative Intensity	PCDFs	Selected Ions (m/z)	Relative Intensity
Tetra	320/322	0.65-0.89	Tetra	304/306	0.65-0.89
Penta	358/356	0.55-0.75	Penta	342/340	0.55-0.75
Hexa	392/390	0.69-0.93	Hexa	376/374	0.69-0.93
Hepta	426/424	0.83-1.12	Hepta	410/408	0.83-1.12
Octa	458/460	0.75-1.01	Octa	442/444	0.75-1.01

7.2.12 Method SW8290-Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans

Method SW8290 is used to analyze for polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) in water, soil, and waste. This GC/MS method uses matrix-specific extraction, analyte-specific cleanup, and high-resolution capillary column GC/high resolution mass spectrometry techniques to separate and identify the analytes of interest. The sensitivity of the method is dependent on the level of matrix interference. Selected cleanup methods may be used to reduce or eliminate interferences. Target analytes may include all congener classes, tetra- through octa-dioxins and furans. Achieved detection limits vary according to matrix and analyte. Because of the extreme toxicity of these compounds, the analyst must take appropriate precautions during preparation and analysis to prevent accidental exposure. RLs are presented in Table 7.2.12-1.

The calibration, QC, corrective action, and data flagging requirements are given in Table 7.2.12-2.

Table 7.2.12-1. RLs for Method SW8290

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Dioxins and Furans SW8290	2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD)	0.01	ng/L	1.0	ng/kg
	1,2,3,7,8-Pentachlorodibenzo-p-dioxin (PeCDD)	0.01	ng/L	1.0	ng/kg
	1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin (HxCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin (HpCDD)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin (OCDD)	0.05	ng/L	5.0	ng/kg
	2,3,7,8-Tetrachlorodibenzofuran (TCDF)	0.01	ng/L	1.0	ng/kg
	1,2,3,7,8-Pentachlorodibenzofuran (PeCDF)	0.01	ng/L	1.0	ng/kg
	2,3,4,7,8-Pentachlorodibenzofuran (PeCDF)	0.05	ng/L	1.0	ng/kg
	1,2,3,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,7,8,9-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	2,3,4,6,7,8-Hexachlorodibenzofuran (HxCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8-Heptachlorodibenzofuran (HpCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,7,8,9-Heptachlorodibenzofuran (HpCDF)	0.025	ng/L	2.5	ng/kg
	1,2,3,4,6,7,8,9-Octachlorodibenzofuran (OCDF)	0.05	ng/L	5.0	ng/kg

Table 7.2.12-2. Summary of Calibration and QC Procedures for Method SW8290

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8290	Dioxins/ Furans	Mass spectrometer tune	As per method SW8290, section 7.6.2	As per method SW8290, section 7.6.2	Retune instrument; verify	Apply R to the result for the specific analyte(s) for all samples associated with the tune
		Initial and continuing calibration	As per method SW8290, section 7.7	As per method SW8290, section 7.7	Correct problem then repeat calibration	Apply R to the result for the specific analyte(s) for all samples associated with the calibration
		Identification /retention times/ion ratios/ signal to noise/ interferences	As per method SW8290, section 7.8.4	As per method SW8290, section 7.8.4	Correct problem and rerun	Apply R to the result for the specific analyte(s) for all samples associated with the condition
		System performance check	As per method SW8290, section 8.2	As per method SW8290, section 8.2	Correct problem and rerun	Apply R to all results for specific analyte(s) for all samples associated with the check
		Quality control checks	As per method SW8290, section 8.3	As per method SW8290, section 8.3	Correct problem and rerun	Apply R to all results for specific analyte(s) for all samples associated with the QC check
		Internal standard	As per method SW8290, section 8.4	As per method SW8290, section 8.4	Correct problem and rerun	Apply R to all results for specific analyte(s) for all samples associated with the internal standard
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.12-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.13 Method SW8310–Polynuclear Aromatic Hydrocarbons

Method SW8310 is used to determine the concentration of ppb levels of selected polynuclear aromatic hydrocarbons (PAHs) in groundwater and soils by HPLC. Samples are extracted then analyzed by direct injection. Detection is by ultraviolet and fluorescent detectors. RLs are listed in Table 7.2.13-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.13-2 and 7.2.13-3.

Table 7.2.13-1. RLs for Method SW8310

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Polynuclear Aromatic Hydrocarbons SW8310	Acenaphthene	18.0	µg/L	1.2	mg/kg
	Acenaphthylene	23.0	µg/L	1.54	mg/kg
	Anthracene	6.6	µg/L	0.44	mg/kg
	Benzo (a) anthracene	0.13	µg/L	0.009	mg/kg
	Benzo (a) pyrene	0.23	µg/L	0.015	mg/kg
	Benzo (b) fluoranthene	0.18	µg/L	0.012	mg/kg
	Benzo (g,h,i) perylene	0.76	µg/L	0.05	mg/kg
	Benzo (k) fluoranthene	0.17	µg/L	0.011	mg/kg
	Chrysene	1.5	µg/L	0.1	mg/kg
	Dibenzo (a,h) anthracene	0.3	µg/L	0.02	mg/kg
	Fluoranthrene	2.1	µg/L	0.14	mg/kg
	Fluorene	2.1	µg/L	0.14	mg/kg
	Indeno (1,2,3-c,d) pyrene	0.43	µg/L	0.03	mg/kg
	Naphthalene	18.0	µg/L	1.2	mg/kg
	Phenanthrene	6.4	µg/L	0.42	mg/kg
	Pyrene	2.7	µg/L	0.18	mg/kg

Table 7.2.13-2. QC Acceptance Criteria for Method SW8310

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8310	Acenaphthene	43–130	≤ 30	33–140	≤ 50
	Acenaphthylene	49–125	≤ 30	39–135	≤ 50
	Anthracene	54–125	≤ 30	44–135	≤ 50
	Benzo (a) Anthracene	39–135	≤ 30	29–145	≤ 50
	Benzo (a) Pyrene	52–125	≤ 30	42–135	≤ 50
	Benzo (b) Fluoranthene	31–137	≤ 30	25–147	≤ 50
	Benzo (g,h,i) Perylene	53–125	≤ 30	43–135	≤ 50
	Benzo (k) Fluoranthene	60–129	≤ 30	50–139	≤ 50
	Chrysene	59–134	≤ 30	49–144	≤ 50
	Dibenzo (a,h) Anthracene	51–125	≤ 30	41–135	≤ 50
	Fluoranthene	42–125	≤ 30	32–135	≤ 50
	Fluorene	53–125	≤ 30	43–135	≤ 50
	Indeno (1,2,3-c,d) Pyrene	55–125	≤ 30	45–135	≤ 50
	Naphthalene	43–125	≤ 30	33–135	≤ 50
	Phenathrene	52–129	≤ 30	42–139	≤ 50
	Pyrene	55–125	≤ 30	45–135	≤ 50
	Surrogates:				
	Terphenyl-D14	25–157		22–167	

Table 7.2.13-3. Summary of Calibration and QC Procedures for Method SW8310

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8310	PAHs	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD of average CF of all analytes ≤20% and average CF of individual analyte <30% or mean RSD for all analytes ≤20% with no individual analyte RSD > 30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.13-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8310	PAHs	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.13-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.13-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.13-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.13-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8310	PAHs	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.13-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Confirmation[c]	100% for all positive results	Same as for initial or primary analysis	Same as for initial or primary analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.13-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.
c. Use a second column or different detector

7.2.14 Method SW8330–Explosive Residues

Method SW8330 provides HPLC conditions for the detection of ppb levels of certain explosive residues in a water, soil, and sediment matrix. Prior to using this method, appropriate sample preparation techniques must be used.

In the low-level, salting-out method with no evaporation, aqueous samples of low concentration are extracted by a salting-out extraction procedure. An aliquot of the extract is separated on a C-18 reverse-phase column, determined at 254 nm, and confirmed on a cyanide reverse-phase column.

In the high-level direct injection method, aqueous samples of higher concentration can be diluted, filtered, separated on a C-18 reverse-phase column, determined at 254 nm, and confirmed on a cyanide reverse-phase column.

Soil and sediment samples are extracted in an ultrasonic bath and filtered before chromatography.

RLs are listed in Table 7.2.14-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.14-2 and 7.2.14-3.

Table 7.2.14-1. RLs for Method SW8330

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
Explosive Residues SW8330	1,3,5- TNB	7.3	µg/L	0.25	mg/kg
	1,3- DNB	4.0	µg/L	0.25	mg/kg
	2,4,6- TNT	6.9	µg/L	0.25	mg/kg
	2,4-DNT	5.7	µg/L	0.25	mg/kg
	2,6-DNT	9.4	µg/L	0.26	mg/kg
	HMX	13.0	µg/L	2.2	mg/kg
	m-Nitrotoluene	7.9	µg/L	0.25	mg/kg
	Methyl-2,4,6-trinitrophenylnitramine	44.0	µg/L	0.65	mg/kg
	Nitrobenzene	7.0	µg/L	0.26	mg/kg
	o-Nitrotoluene	12.0	µg/L	0.25	mg/kg
	p-Nitrotoluene	8.5	µg/L	0.25	mg/kg
	RDX	14.0	µg/L	1.0	mg/kg

Table 7.2.14-2. QC Acceptance Criteria for Method SW8330

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW8330	1,3,5-TNB	75–142	≤ 30	65–152	≤ 50
	1,3-DNB	75–125	≤ 30	65–135	≤ 50
	2,4,6-TNT	75–128	≤ 30	65–138	≤ 50
	2,4-DNT	75–125	≤ 30	65–135	≤ 50
	2,6-DNT	75–129	≤ 30	65–139	≤ 50
	HMX	74–137	≤ 30	64–147	≤ 50
	m-Nitrotoluene	60–134	≤ 30	50–144	≤ 50
	Methyl-2,4,6-Trinitrophenylnitramine	44–142	≤ 30	34–152	≤ 50
	Nitrobenzene	29–134	≤ 30	25–144	≤ 50
	o-Nitrotoluene	75–129	≤ 30	65–139	≤ 50
	p-Nitrotoluene	42–150	≤ 30	32–160	≤ 50
	RDX	75–132	≤ 30	65–142	≤ 50
	Surrogates*[a]*:				

a. Use an analyte and its LCS limit from the method that is not expected to be present in the sample as the surrogate.

Table 7.2.14-3. Summary of Calibration and QC Procedures for Method SW8330

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8330	Explosives	Five-point initial calibration for all analytes	Initial calibration prior to sample analysis	linear - mean RSD of average CF of all analytes ≤20% and average CF of individual analyte <30% or mean RSD for all analytes ≤20% with no individual analyte RSD > 30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
				linear – least squares regression r > 0.995		
				non-linear – COD ≥ 0.990 (6 points shall be used for second order, 7 points shall be used for third order)		
		Second-source calibration verification	Once per five-point initial calibration	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time from 72-hour study	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis	All analytes within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	All analytes within ±15% of expected value	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.14-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8330	Explosives	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.14-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.14-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Surrogate spike	Every sample, spiked sample, standard, and method blank	QC acceptance criteria, Table 7.2.14-2	Correct problem then reextract and analyze sample	For the samples; if the %R > UCL for any surrogate, apply J to all positive results if the %R < LCL for any surrogate, apply J to all positive results, apply R to all non-detects If any surrogate recovery is < 10%, apply R to all results

Table 7.2.14-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW8330	Explosives	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.14-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Confirmation[c]	100% for all positive results	Same as for initial or primary analysis	Same as for initial or primary analysis	Apply R to the result for the specific analyte(s) in the sample not confirmed. Apply J if RPD >40% from first result
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.14-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.
c. Use a second column or different detector

7.2.15 Method SW6010B-Trace Elements (Metals) by Inductively Coupled Plasma Atomic Emission Spectroscopy for Water and Soil

Samples are analyzed for trace elements or metals using method SW6010B for water and soils. Analysis for most metals requires digestion of the sample. Following digestion, the trace elements are determined simultaneously or sequentially using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPES). The elements and corresponding RLs for this method are listed in Table 7.2.15-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.15-2 and 7.2.15-3.

Table 7.2.15-1. RLs for Method SW6010B

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
ICP Screen for Metals SW6010B	Aluminum	0.2	mg/L	22.0	mg/kg
	Antimony	0.05	mg/L	10.0	mg/kg
	Arsenic	0.03	mg/L	40.0	mg/kg
	Barium	0.005	mg/L	1.0	mg/kg
	Beryllium	0.005	mg/L	1.0	mg/kg
	Cadmium	0.007	mg/L	0.50	mg/kg
	Calcium	1.1	mg/L	100	mg/kg
	Chromium	0.01	mg/L	20	mg/kg
	Cobalt	0.006	mg/L	10.0	mg/kg
	Copper	0.01	mg/L	2.0	mg/kg
	Iron	0.20	mg/L	3.0	mg/kg
	Lead	0.025	mg/L	10.0	mg/kg
	Magnesium	0.10	mg/L	100	mg/kg
	Manganese	0.003	mg/L	2.0	mg/kg
	Molybdenum	0.015	mg/L	3.0	mg/kg
	Nickel	0.01	mg/L	2.0	mg/kg
	Potassium	0.50	mg/L	600	mg/kg
	Selenium	0.03	mg/L	3.0	mg/kg
	Silver	0.01	mg/L	1.0	mg/kg
	Sodium	1.0	mg/L	10.0	mg/kg
	Thallium	0.08	mg/L	6.0	mg/kg
	Vanadium	0.01	mg/L	1.0	mg/kg
	Zinc	0.01	mg/L	1.0	mg/kg

Table 7.2.15-2. QC Acceptance Criteria for Method SW6010B

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW6010B	Aluminum	75-125	≤ 20	75-125	≤ 20
	Antimony	75-125	≤ 20	75-125	≤ 20
	Arsenic	75-125	≤ 20	75-125	≤ 20
	Barium	75-125	≤ 20	75-125	≤ 20
	Beryllium	75-125	≤ 20	75-125	≤ 20
	Cadmium	75-125	≤ 20	75-125	≤ 20
	Calcium	75-125	≤ 20	75-125	≤ 20
	Chromium	75-125	≤ 20	75-125	≤ 20
	Cobalt	75-125	≤ 20	75-125	≤ 20
	Copper	75-125	≤ 20	75-125	≤ 20
	Iron	75-125	≤ 20	75-125	≤ 20
	Lead	75-125	≤ 20	75-125	≤ 20
	Magnesium	75-125	≤ 20	75-125	≤ 20
	Manganese	75-125	≤ 20	75-125	≤ 20
	Molybdenum	75-125	≤ 20	75-125	≤ 20
	Nickel	75-125	≤ 20	75-125	≤ 20
	Potassium	75-125	≤ 20	75-125	≤ 20
	Selenium	75-125	≤ 20	75-125	≤ 20
	Silver	75-125	≤ 20	75-125	≤ 20
	Sodium	75-125	≤ 20	75-125	≤ 20
	Thallium	75-125	≤ 20	75-125	≤ 20
	Vanadium	75-125	≤ 20	75-125	≤ 20
	Zinc	75-125	≤ 20	75-125	≤ 20

Table 7.2.15-3. Summary of Calibration and QC Procedures for Method SW6010B

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6010B	ICP Metals	Initial calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	N/A	N/A	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not done
		Initial calibration verification (second source)	Daily after initial calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration blank	After every calibration verification	No analytes detected ≥ RL	Correct problem then analyze calibration blank and previous 10 samples	Apply B to all results for specific analyte(s) in all samples associated with the blank
		Calibration verification (Instrument Check Standard)	After every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value and RSD of replicate integrations <5%	Repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.15-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst

Table 7.2.15-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6010B	ICP Metals	Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		Interference check solution (ICS)	At the beginning of an analytical run	Within ±20% of expected value	Terminate analysis; correct problem; reanalyze ICS; reanalyze all affected samples	Apply R to all results for specific analyte(s) in all samples associated with the ICS
		LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.15-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test	Each new sample matrix	1:5 dilution must agree within ±10% of the original determination	Perform post digestion spike addition	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%

Table 7.2.15-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6010B	ICP Metals	Post digestion spike addition	When dilution test fails	Recovery within 75-125% of expected results	Correct problem then reanalyze post digestion spike addition	Apply J to all sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition If post digestion spike addition recovery is < 10%, apply R to all sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.15-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.15-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.16 Method SW6020-Trace Elements (Metals) by Inductively Coupled Plasma Mass Spectroscopy for Water and Soil

Samples are analyzed for trace elements or metals using method SW6020 for water and soils. Analysis for total (i.e., acid leachable) metals requires digestion of the sample. Following digestion, the trace elements are determined simultaneously or sequentially using Inductively Coupled Plasma Mass Spectroscopy (ICP-MS). The elements and RLs for this method are listed in Table 7.2.16-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.16-2 and 7.2.16-3.

Table 7.2.16-1. RLs for Method SW6020

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
ICP Screen for Metals SW6020	Aluminum	0.02	mg/L	2.0	mg/kg
	Antimony	0.001	mg/L	0.10	mg/kg
	Arsenic	0.02	mg/L	2.0	mg/kg
	Barium	0.003	mg/L	0.30	mg/kg
	Beryllium	0.003	mg/L	0.30	mg/kg
	Cadmium	0.002	mg/L	0.20	mg/kg
	Chromium	0.004	mg/L	0.40	mg/kg
	Cobalt	0.0008	mg/L	0.08	mg/kg
	Copper	0.006	mg/L	0.60	mg/kg
	Lead	0.002	mg/L	0.20	mg/kg
	Manganese	0.002	mg/L	0.20	mg/kg
	Nickel	0.002	mg/L	0.20	mg/kg
	Silver	0.002	mg/L	0.20	mg/kg
	Thallium	0.0002	mg/L	0.02	mg/kg
	Zinc	0.025	mg/L	2.5	mg/kg

Table 7.2.16-2. QC Acceptance Criteria for Method SW6020

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW6020	Aluminum	80–120	≤ 15	80–120	≤ 25
	Antimony	80–120	≤ 15	80–120	≤ 25
	Arsenic	80–120	≤ 15	80–120	≤ 25
	Barium	80–120	≤ 15	80–120	≤ 25
	Beryllium	80–120	≤ 15	80–120	≤ 25
	Cadmium	80–120	≤ 15	80–120	≤ 25
	Chromium	80–120	≤ 15	80–120	≤ 25
	Cobalt	80–120	≤ 15	80–120	≤ 25
	Copper	80–120	≤ 15	80–120	≤ 25
	Lead	80–120	≤ 15	80–120	≤ 25
	Manganese	80–120	≤ 15	80–120	≤ 25
	Nickel	80–120	≤ 15	80–120	≤ 25
	Silver	80–120	≤ 15	80–120	≤ 25
	Thallium	80–120	≤ 15	80–120	≤ 25
	Zinc	80–120	≤ 15	80–120	≤ 25

Table 7.2.16-3. Summary of Calibration and QC Procedures for Method SW6020

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6020	ICP/MS Metals	MS tuning sample	Prior to initial calibration and calibration verification	SW6020 paragraph 5.8	Retune instrument then reanalyze tuning solution	Apply R to all results for all analytes for all samples associated with the MS tuning
		Initial calibration (minimum 1 standard and a blank)	Daily initial calibration prior to sample analysis	N/A	N/A	Apply R to all results for specific analyte(s) for all samples associated with the calibration if calibration not done
		Calibration blank	Before beginning a sample run, after every 10 samples and at end of the analysis sequence	No analytes detected ≥ RL	Correct problem then analyze calibration blank and previous 10 samples	Apply B to all results for specific analyte(s) in all samples associated with the blank
		Calibration verification (Second source standard)	Before beginning a sample run, after every 10 samples and at the end of the analysis sequence	All analyte(s) within ±10% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.16-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst

Table 7.2.16-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6020	ICP/MS Metals	Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		Interference check solutions (ICS-A and ICS-AB)	At the beginning and end of an analytical run or twice during an 12 hour period, whichever is more frequent	ICS-A All non-spiked analytes < RL ICS-AB Within ±20% of true value	Terminate analysis; locate and correct problem; reanalyze ICS; reanalyze all affected samples	Apply R to all results for specific analyte(s) in all samples associated with the ICS
		LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.16-2	Correct problem reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test	Each preparatory batch	1:4 dilution must agree within ±10% of the original determination	Perform post digestion spike addition	Apply J to all sample results if post digestion spike test not performed
		Post digestion spike addition	When dilution test fails	Recovery within 75-125% of expected results	Dilute the sample; reanalyze post digestion spike addition	Apply J to all sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition

Table 7.2.16-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW6020	ICP/MS Metals	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.16-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Internal Standards (ISs)	Every sample	IS intensity within 30-120% of intensity of the IS in the initial calibration	Perform corrective action as described in method SW6020, section 8.3	Apply R to all results for specific analyte(s) in all samples associated with the IS.
		MDL study	Every three months	Detection limits established shall be ≤ ½ the RLs in Table 7.2.16-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.17 Method SW7041–Graphite Furnace Atomic Absorption (Antimony)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted then discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the antimony. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.17-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.17-2 and 7.2.17-3.

Table 7.2.17-1. RLs for Method SW7041

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
SW7041	Antimony	0.005	mg/L	0.5	mg/kg

Table 7.2.17-2. QC Acceptance Criteria for Method SW7041

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7041	Antimony	75–125	≤ 15	75–125	≤ 15

Table 7.2.17-3. Summary of Calibration and QC Procedures for Method SW7041

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7041	Antimony	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.17-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.17-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7041	Antimony	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.17-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution Test; 1:4 dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.17-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7041	Antimony	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.17-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.17-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.18 Method SW7060A–Graphite Furnace Atomic Absorption (Arsenic)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the arsenic. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.18-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.18-2 and 7.2.18-3.

Table 7.2.18-1. RLs for Method SW7060A

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7060A	Arsenic	0.005	mg/L	0.5	mg/kg

Table 7.2.18-2. QC Acceptance Criteria for Method SW7060A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7060A	Arsenic	74-120	≤ 15	74-120	≤ 15

Table 7.2.18-3. Summary of Calibration and QC Procedures for Method SW7060A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7060A	Arsenic	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.18-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.18-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7060A	Arsenic	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.18-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.18-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7060A	Arsenic	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.18-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.18-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.19 Method SW7131A–Graphite Furnace Atomic Absorption (Cadmium)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Cadmium. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analyzes are listed in Table 7.2.19-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.19-2 and 7.2.19-3.

Table 7.2.19-1. RLs for Method SW7131A

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7131A	Cadmium	0.001	mg/L	0.1	mg/kg

Table 7.2.19-2. QC Acceptance Criteria for Method SW7131A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7131A	Cadmium	80-122	≤ 15	80-122	≤ 15

Table 7.2.19-3. Summary of Calibration and QC Procedures for Method SW7131A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7131A	Cadmium	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.19-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.19-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7131A	Cadmium	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.19-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		New matrix check; five-fold dilution test	Each new sample matrix	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) new matrix check not run (2) RPD ≥10%
		Recovery test	When new matrix check fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.19-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7131A	Cadmium	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.19-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.19-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.20 Method SW7191–Graphite Furnace Atomic Absorption (Chromium)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Chromium. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analyzes are listed in Table 7.2.20-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.20-2 and 7.2.20-3.

Table 7.2.20-1. RLs for Method SW7191

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7191	Chromium	0.005	mg/L	0.5	mg/kg

Table 7.2.20-2. QC Acceptance Criteria for Method SW7191

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7191	Chromium	80-121	≤ 15	80-121	≤ 15

Table 7.2.20-3. Summary of Calibration and QC Procedures for Method SW7191

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7191	Chromium	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.20-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.20-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7191	Chromium	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.20-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		New matrix check; five-fold dilution test	Each new sample matrix	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) new matrix check not run (2) RPD ≥10%
		Recovery test	When new matrix check fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.20-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7191	Chromium	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.20-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.20-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.21 Method SW7196A-Hexavalent Chromium (Colorimetric)

Dissolved hexavalent chromium, in the absence of interfering amounts of substances such as molybdenum, vanadium, and mercury, may be determined colorimetrically. RLs for this method are listed in Table 7.2.21-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.21-2 and 7.2.21-3.

Table 7.2.21-1. RLs for Method SW7196A

		Water		Soil	
Parameter/Method	**Analyte**	**RL**	**Unit**	**RL**	**Unit**
SW7196A	Hexavalent Chromium	0.5	mg/L	1.0	mg/kg

Table 7.2.21-2. QC Acceptance Criteria for Method SW7196A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7196A	Hexavalent Chromium	86–117	≤ 15	86–117	≤ 25

Table 7.2.21-3. Summary of Calibration and QC Procedures for Method SW7196A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7196A	Hexavalent Chromium	Multipoint calibration curve (minimum three standards and a blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to the specific analyte result for all samples associated with the calibration
		Second-source calibration verification	After each new stock standard preparation	Analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to the specific analyte result for all samples associated with the calibration
		Calibration verification	After every 15 samples and at the end of the analysis sequence	Chromium within ±20% of expected value	Correct problem then repeat initial calibration and reanalyze all samples since last successful calibration	Apply R to the specific analyte result in all samples since the last acceptable calibration verification
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.21-2	Recalculate results; locate and fix problem with system and then rerun demonstration	Apply R to the specific analyte result for all samples analyzed by the analyst
		Verification check to ensure lack of reducing condition and/or interference	Once for every sample matrix analyzed	Spike recovery between 85-115%	If check indicates interference, dilute and reanalyze sample persistent interference indicates the need to use and alternate method	Apply R to the specific analyte result for all samples analyzed since the last acceptable verification check
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.21-1	none	Apply R to all specific analyte results for all samples analyzed

Table 7.2.21-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7196A	Chromium	Method blank	One per analytical batch	No analyte detected > RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to the specific analyte result for all samples in the associated analytical batch
		LCS	One LCS per analytical batch	QC acceptance criteria, Table 7.2.21-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.21-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if;(1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.22 Method SW7421–Graphite Furnace Atomic Absorption (Lead)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Lead. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.22-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.22-2 and 7.2.22-3.

Table 7.2.22-1. RLs for Method SW7421

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7421	Lead	0.005	mg/L	0.5	mg/kg

Table 7.2.22-2. QC Acceptance Criteria for Method SW7421

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7421	Lead	74-124	≤ 15	74-124	≤ 25

Table 7.2.22-3. Summary of Calibration and QC Procedures for Method SW7421

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7421	Lead	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.22-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.22-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7421	Lead	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.22-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.22-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7421	Lead	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.22-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.22-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.23 Method SW7470A/SW7471A–Mercury Manual Cold-Vapor Technique

Water and soil samples are analyzed for mercury using methods SW7470A and SW7471A, respectively. This method is a cold-vapor, flameless atomic absorption (AA) technique based on the absorption of radiation by mercury vapor. Mercury is reduced to the elemental state and aerated from solution in a closed system. The mercury vapor passes through a cell positioned in the light path of an AA spectrophotometer. Mercury concentration is measured as a function of absorbance. The RLs for these methods are listed in Table 7.2.23-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.23-2 and 7.2.23-3.

Table 7.2.23-1. RLs for Method SW7470A/SW7471A

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7470A (W) SW7471A (S)	Mercury	0.001	mg/L	0.1	mg/kg

Table 7.2.23-2. QC Acceptance Criteria for Method SW7470A/SW7471A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7470A/SW7471A	Mercury	77–120	≤ 15	77–120	≤ 25

Table 7.2.23-3. Summary of Calibration and QC Procedures for Method SW7470A/SW7471A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7470A SW7471A	Mercury	Initial multipoint calibration (minimum 5 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.23-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.23-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7470A SW7471A	Mercury	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.23-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.23-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7470A SW7471A	Mercury	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.23-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.23-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.24 Method SW7521–Graphite Furnace Atomic Absorption (Nickel)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the nickel. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.24-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.24-2 and 7.2.24-3.

Table 7.2.24-1. RLs for Method SW7521

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7521	Nickel	0.005	mg/L	0.05	mg/kg

Table 7.2.24-2. QC Acceptance Criteria for Method SW7521

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7521	Nickel	75-125	≤15	75-125	≤25

Table 7.2.24-3. Summary of Calibration and QC Procedures for Method SW7521

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7521	Nickel	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.24-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.24-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7521	Nickel	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.24-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.24-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7521	Nickel	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.24-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.24-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.25 Method SW7740-Graphite Furnace Atomic Absorption (Selenium)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are prepared as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Selenium. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.25-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.25-2 and 7.2.25-3.

Table 7.2.25-1. RLs for Method SW7740

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7740	Selenium	0.005	mg/L	0.5	mg/kg

Table 7.2.25-2. QC Acceptance Criteria for Method SW7740

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7740	Selenium	73-122	≤ 15	73-122	≤ 25

Table 7.2.25-3. Summary of Calibration and QC Procedures for Method SW7740

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7740	Selenium	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.25-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.25-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7740	Selenium	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.25-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.25-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7740	Selenium	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.25-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.25-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.26 Method SW7841–Graphite Furnace Atomic Absorption (Thallium)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Thallium. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.26-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.26-2 and 7.2.26-3.

Table 7.2.26-1. RLs for Method SW7841

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7841	Thallium	0.001	mg/L	0.1	mg/kg

Table 7.2.26-2. QC Acceptance Criteria for Method SW7841

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7841	Thallium	78-123	≤ 15	78-123	≤ 25

Table 7.2.26-3. Summary of Calibration and QC Procedures for Method SW7841

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7841	Thallium	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.26-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.26-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7841	Thallium	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.26-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.26-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7841	Thallium	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.26-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.26-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.27 Method SW7911-Graphite Furnace Atomic Absorption (Vanadium)

GFAA is used to measure low concentrations of metals in water and soil samples. The samples are extracted as appropriate. Discrete aliquots of sample extract are deposited in a graphite tube furnace in microliter amounts. The graphite tube is heated resistively by an electrical current. The sample solution is dried and charred to remove sample matrix components and then atomized at temperatures sufficient to vaporize the Vanadium. Matrix modification is used to eliminate interference effects and may also enhance the vaporization efficiency and allow lower detection limits. RLs for this analysis are listed in Table 7.2.27-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.27-2 and 7.2.27-3.

Table 7.2.27-1. RLs for Method SW7911

Parameter/Method	Analyte	Water		Soil	
		RL	Unit	RL	Unit
SW7911	Vanadium	0.004	mg/L	0.4	mg/kg

Table 7.2.27-2. QC Acceptance Criteria for Method SW7911

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW7911	Vanadium	78-123	≤ 15	78-123	≤ 25

Table 7.2.27-3. Summary of Calibration and QC Procedures for Method SW7911

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7911	Vanadium	Initial multipoint calibration (minimum 3 standards and a blank)	Daily initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Second-source calibration check standard	Once per initial daily multipoint calibration	Analyte within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte for all samples associated with the calibration
		Calibration blank	Once per initial daily multipoint calibration	No analyte detected ≥ RL	Correct problem then reanalyze calibration blank and all samples associated with blank	Apply B to all results for the specific analyte in all samples associated with the blank
		Calibration verification	After every 10 samples and at the end of the analysis sequence	The analyte within ±20% of expected value	Correct problem then repeat calibration and reanalyze all samples since last successful calibration	Apply R to all results for the specific analyte in all samples since the last acceptable calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.27-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte in all samples in the associated analytical batch

Table 7.2.27-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7911	Vanadium	LCS for the analyte	One LCS per analytical batch	QC acceptance criteria, Table 7.2.27-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Dilution test; five-fold dilution test	Each preparatory batch	Five times dilution sample result must be ±10% of the undiluted sample result	Perform recovery test	Apply J to all sample results if either of following exist: (1) dilution test not run (2) RPD ≥10%
		Recovery test	When dilution test fails	Recovery within 85-115% of expected results	Run all samples by the method of standard addition	Apply J to all sample results (for same matrix) in which method of standard addition was not run when recovery outside of 85-115% range

Table 7.2.27-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW7911	Vanadium	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.27-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.27-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.28 Method SW9010B/SW9012A-Total Cyanide and Cyanide Amenable to Chlorination

Water and waste samples are analyzed for total cyanide using method SW9010B or SW9012A. These methods are equivalent in principle of analysis; SW9010B is a manual procedure, and SW9012A is an automated procedure.

Both methods are used to determine the concentration of inorganic cyanide in aqueous wastes and leachates. The methods detect inorganic cyanides that are present as either sample soluble salts or complex radicals. It is used to determine values for both total cyanide and cyanide amenable to chlorination. The cyanide is released by refluxing the sample with a strong acid and catalyst and distillation. Total cyanide in soils is determined after acidification of the soil and distillation. The cyanide ion in the absorbing solution is then determined by spectrophotometry for method SW9010B and by automated colorimetry for method SW9012A. RLs for cyanide are listed in Table 7.2.28-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.28-2 and 7.2.28-3.

Table 7.2.28-1. RLs for Method SW9010B/SW9012A

Parameter/Method	Analyte	Water RL	Water Unit
SW9010B/SW9012A	Total cyanide	0.02	mg/L

Table 7.2.28-2. QC Acceptance Criteria for Method SW9010B/SW9012A

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)
SW9010B SW9012A	Total cyanide	79–114	≤ 20

Table 7.2.28-3. Summary of Calibration and QC Procedures for Method SW9010B/SW9012A

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW9010B/ SW9012A	Cyanide	Multipoint calibration curve (six standards and a calibration blank)	Initial daily calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to the result for cyanide for all samples associated with the calibration
		Distilled standards (one high and one low)	Once per multipoint calibration	Cyanide within ±10% of true value	Correct problem then repeat distilled standards	Apply R to all results for the specific analyte for all samples associated with the calibration
		Second-source calibration verification	Once per stock standard preparation	Cyanide within ±15% of expected value	Correct problem then repeat initial calibration	Apply R to the result for the specific analyte for all samples associated with the calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.28-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to the specific analyte result for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to the result for the specific analyte in all samples in the associated analytical batch

Table 7.2.28-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW9010B/ SW9012A	Cyanide	LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.22-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For the specific analyte in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.22-2	none	For the specific analyte in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.22-1	none	Apply R to all results for the specific analyte in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.29 Method SW9056–Common Anions

This method addresses the sequential determination of the anions chloride, fluoride, bromide, nitrate, nitrite, phosphate, and sulfate in the collection solutions from the bomb combustion of solid waste samples, as well as water samples.

A small volume of combustate collection solution or other water sample is injected into an ion chromatograph to flush and fill a constant volume sample loop. The sample is then injected into a stream of elutent.

The sample is pumped through three different ion exchange columns and into a conductivity detector. The first two columns, a precolumn (guard) column and a separator column, are packed with a low-capacity, strongly basic anion exchanger. Ions are separated into discrete bands based on their affinity for the exchange sites of the resin. The last column is a suppressor column that reduces the anions in the sample to their corresponding acids. The separated anions in their acid form are measured using an electrical-conductivity cell. Anions are identified based on their retention times compared to known standards. Quantitation is accomplished by measuring the peak height or area and comparing it to a calibration curve generated from known standards.

RLs are listed in Table 7.2.29-1. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.29-2 and 7.2.29-3.

Table 7.2.29-1. RLs for Method SW9056

Parameter/Method	Analyte	Water RL	Water Unit	Soil RL	Soil Unit
Common Anions SW9056	Bromide	0.5	mg/L	0.5	mg/kg
	Chloride	1.0	mg/L	1.0	mg/kg
	Fluoride	1.0	mg/L	1.0	mg/kg
	Nitrate	1.0	mg/L	1.0	mg/kg
	Nitrite	1.0	mg/L	1.0	mg/kg
	Phosphate	1.0	mg/L	1.0	mg/kg
	Sulfate	1.0	mg/L	1.0	mg/kg

Table 7.2.29-2. QC Acceptance Criteria for Method SW9056

Method	Analyte	Accuracy Water (% R)	Precision Water (% RPD)	Accuracy Soil (% R)	Precision Soil (% RPD)
SW9056	Bromide	86–112	≤ 20	86–112	≤ 30
	Chloride	91–111	≤ 20	91–111	≤ 30
	Fluoride	86–114	≤ 20	86–114	≤ 30
	Nitrate	90–110	≤ 20	90–110	≤ 30
	Nitrite	88–116	≤ 20	88–116	≤ 30
	Phosphate	87–110	≤ 20	87–110	≤ 30
	Sulfate	88–115	≤ 20	88–115	≤ 30

Table 7.2.29-3. Summary of Calibration and QC Procedures for Method SW9056

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW9056	Common anions	Multipoint calibration for all analytes (minimum 3 standards and one calibration blank)	Initial calibration prior to sample analysis	Correlation coefficient ≥0.995 for linear regression	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Second-source calibration verification	Once per multipoint calibration	All analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Retention time window calculated for each analyte	Each initial calibration and calibration verifications	± 3 times standard deviation for each analyte retention time over 8 hour period	Correct problem then reanalyze all samples analyzed since the last retention time check	Apply R to all results for the specific analyte(s) in the sample
		Initial calibration verification	Daily, before sample analysis or when elutent is changed	All analytes within ±10% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification	After every 10 samples and at the end of the analysis sequence	Instrument response within ±5% of expected response	Correct problem then repeat initial calibration verification and reanalyze all samples since last successful calibration verification	Apply R to all results for the specific analyte(s) in all samples since the last acceptable calibration verification

Table 7.2.29-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW9056	Common anions	Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.29-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.29-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects
		Duplicate	One per every 10 samples	%D ≤10%		For specific analyte(s) in all samples in the associated analytical batch apply J to all results

Table 7.2.29-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
SW9056	Common anions	MS/MSD	One MS/MSD per every 20 Air Force project samples per matrix	QC acceptance criteria, Table 7.2.29-2	none	For the specific analyte(s) in all samples collected from the same site matrix as the parent, apply M if; (1)%R for MS or MSD > UCL or (2)%R for MS or MSD < LCL or (3)MS/MSD RPD > CL
		MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.29-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

7.2.30 Method TO-14 -Volatile Organics in Ambient Air

Volatile organics in air are sampled and analyzed using method TO-14. This method uses a high resolution GC coupled to one or more appropriate detectors (AFCEE requires the use of a mass-selective detector). The analytes detected and RLs for this method are listed in Table 7.2.30-1.

Calibration—The mass spectrometer is tuned daily to give an acceptable spectrum for BFB. The tuning acceptance criteria are given in the following list as an ion abundance for each specified mass:

- mass 50 15 percent to 40 percent of mass 95
- mass 75 30 percent to 60 percent of mass 95
- mass 95 base peak, 100 percent relative abundance
- mass 96 5 percent to 9 percent of mass 95
- mass 173 less than 2 percent of mass 174
- mass 174 greater than 50 percent of mass 95
- mass 175 5 percent to 9 percent of mass 174
- mass 176 greater than 95 percent, but less than 101 percent of mass 174
- mass 177 5 percent to 9 percent of mass 176

The IS method is used for quantitation of analytes of interest. For quantitation, RFs are calculated from the base ion peak of a specific IS added to each calibration standard, blank, QC sample, and sample. The calibration, QC, corrective action, and data flagging requirements are given in Tables 7.2.30-2 and 7.2.30-3.

Table 7.2.30-1. RLs for Method TO-14

Parameter/Method	Analyte	Air	
		RL	Unit
VOCs TO-14	1,1,1-TCA	0.8	µg/L
	1,2-DCA	0.6	µg/L
	1,2-Dibromoethane	0.6	µg/L
	Benzene	0.4	µg/L
	Carbon tetrachloride	2.1	µg/L
	Chloroform	0.3	µg/L
	m-Xylene	0.5	µg/L
	o-Xylene	1.1	µg/L
	p-Xylene	1.3	µg/L
	Styrene	0.4	µg/L
	TCE	1.0	µg/L

Table 7.2.30-2. QC Acceptance Criteria for Method TO-14

Method	Analyte	Accuracy Air (% R)	Precision Air (% RPD)
TO-14	1,1,1-TCA	72–125	≤ 20
	1,2-DCA	75–125	≤ 20
	1,2-Dibromoethane	74–125	≤ 20
	Benzene	75–127	≤ 20
	Carbon tetrachloride	72–125	≤ 20
	Chloroform	75–125	≤ 20
	m-Xylene	75–125	≤ 20
	o-Xylene	75–137	≤ 20
	p-Xylene	75–125	≤ 20
	Styrene	75–135	≤ 20
	TCE	75-125	≤ 20

Table 7.2.30-3. Summary of Calibration and QC Procedures for Method TO-14

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
TO-14	Volatile Organics	Initial multipoint calibration (minimum 3 standards and humid zero air)	Initial calibration prior to sample analysis	%RSD for all calibration analytes ≤ 30%	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Second-source calibration verification	Once per three-point initial calibration	All analytes within ±25% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Calibration verification (one point)	Daily, before sample analysis and every 12 hours of analysis time	All calibration analytes within ±25% of expected value	Correct problem then repeat initial calibration	Apply R to all results for specific analyte(s) for all samples associated with the calibration
		Demonstrate ability to generate acceptable accuracy and precision using four replicate analyzes of a QC check sample	Once per analyst	QC acceptance criteria, Table 7.2.30-2	Recalculate results; locate and fix problem with system and then rerun demonstration for those analytes that did not meet criteria	Apply R to all results for all samples analyzed by the analyst
		Check of mass spectral ion intensities using BFB	Prior to initial calibration and calibration verification	Refer to criteria listed in the method description	Retune instrument and verify	Apply R to all results for all samples associated with the tune

Table 7.2.30-3. Continued

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
TO-14	Volatile Organics	ISs	Immediately after or during data acquisition for the calibration verification standard.	Retention time ±30 seconds from retention time of the mid-point std. in the ICAL. EICP area within -50% to +100% of ICAL mid-point std.	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Apply R to all results for analytes associated with the IS
		Method blank	One per analytical batch	No analytes detected ≥ RL	Correct problem then reprep and analyze method blank and all samples processed with the contaminated blank	Apply B to all results for the specific analyte(s) in all samples in the associated analytical batch
		LCS for all analytes	One LCS per analytical batch	QC acceptance criteria, Table 7.2.30-2	Correct problem then reprep and analyze the LCS and all samples in the affected AFCEE analytical batch	For specific analyte(s) in all samples in the associated analytical batch; if the LCS %R > UCL, apply J to all positive results if the LCS %R < LCL, apply J to all positive results, apply R to all non-detects

Table 7.2.30-3. Concluded

Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action[a]	Flagging Criteria[b]
TO-14	Volatile Organics	MDL study	Once per 12 month period	Detection limits established shall be ≤ ½ the RLs in Table 7.2.30-1	none	Apply R to all results for the specific analyte(s) in all samples analyzed
		Results reported between MDL and RL	none	none	none	Apply F to all results between MDL and RL

a. All corrective actions associated with AFCEE project work shall be documented, and all records shall be maintained by the laboratory.
b. Flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

8.0 DATA REDUCTION, REVIEW, VERIFICATION, REPORTING, VALIDATION, AND RECORDKEEPING

The data reduction, review, reporting, and validation procedures described in this section will ensure; (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified if necessary. Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications.

8.1 DATA REVIEW, VALIDATION, AND REPORTING REQUIREMENTS FOR SCREENING DATA

The analysts shall perform a 100 percent review of the screening data. The screening data methods are identified in Table 6-1 of Section 6. All screening data shall be qualified with an *S* flag and shall be further qualified if critical calibration and QC requirements are not acceptable. The calibration, QC requirements, corrective action requirements, and flagging criteria required are shown in Table 6.2-1 in Section 6. The flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed. "*S*" designator flags shall be maintained in the final data qualification. When the data are reviewed and qualified, the analyst shall apply a final qualifier to any data that has been affected by multiple qualifiers. This final qualifier shall reflect the most severe qualifier that was applied to the data. The allowable final data qualifiers for screening data and the hierarchy of data qualifiers, listed in order of the most severe through the least severe, are *SR, SJ, SB*, and *SU.* Therefore, the allowable final data qualifiers for screening data are *SR, SJ, SB, SU, and S.*

The definitions of the data qualifiers are shown in Table 8.2-1. A summary of the flagging conventions of field screening methods is given in Table 6.2-1.

Screening data report packages shall be prepared for all field analyses as described in Section 8.8. The screening data shall be reported on the AFCEE screening data report forms (AFCEE Forms S-1 through S-3), as illustrated in Section 8.8. The prime contractor's project manager shall review the entire screening data report package with the field records. The prime contractor (1) shall determine if the data quality objectives have been met, and (2) shall calculate the data completeness for the project. These results shall be included in the data package deliverable.

8.2 DATA REVIEW, VALIDATION, AND REPORTING REQUIREMENTS FOR DEFINITIVE DATA

MDLs and results shall be reported to one decimal place more than the corresponding RL. Soil/sediment samples shall have results reported on a dry weight basis. A wet weight aliquot of sample equivalent to the method specified dry weight aliquot of sample shall be taken for analysis (i.e., RLs and MDLs are NOT adjusted for dry weight). RLs and MDLs are adjusted for dilutions.

In each laboratory analytical section, the analyst performing the tests shall review 100 percent of the definitive data. After the analyst's review has been completed, 100 percent of the data shall be reviewed independently by a senior analyst or by the supervisor of the respective analytical section using the same criteria.

The definitive data methods are identified in Section 7.2. The calibration, QC requirements, corrective action requirements, and flagging criteria required for definitive data are shown in the tables in Section 7.2, and in summary Tables 8.2-2, 8.2-3, and 8.2-4. The flagging criteria are applied when acceptance criteria were not met and corrective action was not successful or corrective action was not performed.

Data qualifiers shall be added or, if applied by a software package, reviewed by the laboratory supervisor of the respective analytical section, after the first and second level of laboratory data reviews have been performed. Analytical batch comments shall be added to the first page of the definitive data report packages to explain any nonconformance or other issues. When data are qualified, the laboratory supervisor shall apply a final qualifier to any data that have been affected by multiple qualifiers. This final qualifier shall reflect the most severe qualifier that was applied to the data, i.e., all data will have only one data qualifying flag associate with it. The allowable final data qualifiers for definitive data and the hierarchy of data qualifiers, listed in order of the most severe through the least severe, are *R, M, F, J, B*, and *U.* The definitions of the data qualifiers are shown in Table 8.2-1.

The one exception to these data flagging criteria rules applies to the tentatively identified compounds (TICs) that are identified only in the GC/MS methods. These TICs numerical results will always be qualified with one and only one flag for any reason, and that is the "T" flag.

The laboratory QA section shall perform a 100 percent review of 10 percent of the completed data packages, and the laboratory project manager shall perform a sanity check review on all the completed data packages.

The prime contractor's project manager shall review the entire definitive data report package, and with the field records, apply the final data qualifiers for the definitive data. The laboratory shall apply data qualifying flags to each environmental field QC sample, i.e., ambient blanks, equipment blanks, trip blanks, field duplicates, matrix spike (MS) samples, and matrix spike duplicate (MSD) samples. The prime contractor shall review the field QC samples and field logs, and shall then

appropriately flag any of the associated samples identified with the field QC sample, as explained in Table 8.2-2 and 8.2-3. Each matrix spike sample shall only be qualified by the laboratory, while the prime contractor shall apply the final qualifying flag for a matrix effect to all samples collected from the same site as the parent sample or all samples showing the same lithologic characteristics as the MS/MSD.

The prime contractor (1) shall determine if the data quality objectives have been met, and (2) shall calculate the data completeness for the project. These results shall be included in the data package deliverable as described in Section 8.8.

Table 8.2-1 Data Qualifiers

Qualifier	Description
J	The analyte was positively identified, the quantitation is an estimation.
U	The analyte was analyzed for, but not detected. The associated numerical value is at or below the MDL.
F	The analyte was positively identified but the associated numerical value is below the RL.
R	The data are unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
B	The analyte was found in an associated blank, as well as in the sample.
M	A matrix effect was present.
S	To be applied to all field screening data.
T	Tentatively identified compound (using GC/MS)

Table 8.2-2. General Flagging Conventions

QC Requirement	Criteria	Flag	Flag Applied To
Holding Time	Time exceeded for extraction or analysis	R	All analytes in the sample
LCS	% R > UCL %R < LCL	J for the positive results J for the positive results, R for the nondetects	The specific analyte(s) in all samples in the associated AAB
Method Blank	Analyte(s) detected ≥ RL	B	The specific analyte(s) in all samples in the associated AAB
Equipment Blank	Analyte(s) detected ≥ RL	B	The specific analyte(s) in all samples with the same sampling date as the equipment blank
Field duplicates	Field duplicates > RLs AND RPD outside CL	J for the positive results R for the nondetects	The specific analyte(s) in all samples collected on the same sampling date
MS/MSD	MS or MSD % R > UCL OR MS or MSD % R < LCL OR MS/MSD RPD > CL	M for all results	The specific analyte(s) in all samples collected from the same site as the parent sample
Sample Preservation/ Collection	Preservation/collection requirements not met	R for all results	All analytes in the sample
Sample Storage	< 2°C or > 6°C	J for the positive results R for the nondetects	All analytes in the sample

UCL = upper control limit LCL = lower control limit CL = control limit

	Criteria	Flag*
Quantitation	≤ MDL	U
	> MDL < RL	F
	≥ RL	as needed

* Example 1: if the MDL is 0.04, the RL is 0.9 and the result is 0.03, the concentration reported on the result form would be 0.04 (the MDL) and the qualifier flag would be U.

Example 2: if the MDL is 0.04, the RL is 0.9 and the result is 0.07, the concentration reported on the result form would be 0.07 and the qualifier flag would be F.

Example 3: if the MDL is 0.04, the RL is 0.9 and the result is 1.2, the concentration reported on the result form would be 1.2 and the qualifier would be any flag needed because of a data quality problem (e.g., R, J, B, etc.).

Table 8.2-3. Flagging Conventions Specific to Organic Methods

QC Requirement	Criteria	Flag	Flag Applied To
Ambient Blank (VOC samples only)	Analyte(s) detected ≥ RL	B	The specific analyte(s) in all samples with the same matrix and sampling date
Trip Blank (VOC samples only)	Analyte(s) detected ≥ RL	B	The specific analyte(s) in all samples shipped in the same cooler as the blank
Initial Five Point Calibration (GC & HPLC methods)	Linearity criterion not met	R	The specific analyte(s) in all samples associated with the initial calibration
Initial Five Point Calibration (GC/MS methods)	SPCC or CCC criteria not met	R	All analytes in all samples associated with the initial calibration
	Linearity criterion not met	R	The specific analyte(s) in all samples associated with the initial calibration
Second Source Calibration Verification	CL exceeded	R	The specific analyte(s) in all samples associated with the second source calibration verification
Initial Daily Calibration Verification (GC & HPLC methods)	CL exceeded	R	The specific analyte(s) in all samples associated with the initial calibration verification
Calibration Verification (GC/MS methods)	SPCC or CCC criteria not met	R	All analytes in all samples associated with the calibration verification
	CL exceeded	R	The specific analyte(s) in all samples associated with the calibration verification
Calibration Verification (GC & HPLC methods)	CL exceeded	R	The specific analyte(s) in the sample associated with the continuing calibration verification
Retention time	Retention time of analyte outside of established retention time window	R	The specific analyte(s) in the sample
Surrogates	surrogate % R >UCL OR surrogate % R < LCL OR surrogate recovery < 10%	J for the positive results J for the positive results R for the nondetects R for all results	All analytes in the sample associated with the surrogate
Mass Spectrometer Tune	Ion abundance criteria not met	R for all results	All analytes in all samples associated with the tune

UCL = upper control limit   LCL = lower control limit   CL = control limit

Table 8.2-3. Concluded

QC Requirement	Criteria	Flag	Flag Applied To
Second Column/Second Detector Confirmation (GC & HPLC methods)	Not performed Agreement between results not within ±40%	R J	All analytes ≥RL All affected analytes
Internal Standard	Retention time not within ±30 seconds: EICP area not within -50% to +100% of last calibration verification	R	Apply R to all results for specific analytes associated with the IS
Lowest Calibration Standard	At or below RL in Initial Calibration	R	All results below the lowest calibration standard used
Tentatively Identified Compounds (TICs)		T	All TICs

Table 8.2-4. Flagging Conventions Specific to Inorganic Methods

QC Requirement	Criteria	Flag	Flag Applied To
Initial multipoint calibration	Correlation coefficient < 0.995	R	All results for specific analyte(s) for all samples associated with the initial calibration
Initial calibration verification/second source standard	CL exceeded	R	All results for specific analyte(s) for all samples associated with the calibration verification
Calibration blank	Analyte detected ≥ RL	B	All results for specific analyte(s) in all samples associated with the blank
Calibration verification (Instrument Check Standard)	CL exceeded	R	All results for specific analyte(s) in all samples since the last acceptable calibration verification
Interference check solution (ICS)	CL exceeded	R	All results for specific analyte(s) in all samples associated with the ICS
Dilution test	CL exceeded	J	Apply to all sample results if the new matrix check was not run or RPD ≥10%
Recovery test (GFAA methods)	CL exceeded	J	All samples in digestion batch if method of standard addition is not performed
Post digestion spike addition (ICP method)	CL exceeded	J	All sample results (for same matrix) for specific analyte(s) for all samples associated with the post digestion spike addition
	% R < 10%	R	
Method of standard addition (GFAA methods)	Method of standard addition not done OR method of standard addition spike levels inappropriate OR correlation coefficient < 0.995	J	All positive sample results for specific analyte for all samples associated with the digestion batch

UCL = upper control limit LCL = lower control limit CL = control limit

8.3 QUALITY ASSURANCE REPORTS

The laboratory QA staff shall issue QA reports to the laboratory management, laboratory supervisors and task leaders. These reports shall describe the results of QC measurements, performance audits, and systems audits, and confirmation sample comparisons performed for each sampling and analysis task. Quality problems associated with performance of methods, completeness of data, comparability of data including field and confirmatory data, and data storage shall be documented with the corrective actions that have been taken to correct the deficiencies identified.

8.4 ERPIMS ELECTRONIC DATA REPORTS

The prime contractor shall provide an electronic deliverable report in the Environmental Restoration Program Information Management System (ERPIMS) format as specified by the SOW for the project.

ERPIMS is a data management system designed to accommodate all types of data collected for IRP projects. Specific codes and data forms have been developed to allow consistent and efficient input of information to the system. The database information shall be provided by the prime contractor via ASCII files in specified ERPIMS format on 3.5" floppy diskettes. The information transferred shall include all required technical data such as site information; well characteristics; and hydrogeologic, geologic, physical, and chemical analysis results. Electronic data reporting formats and requirements are given in the most current version of the *ERPIMS Data Loading Handbook*.

8.5 ARCHIVING

Hardcopy and electronic data shall be archived in project files and on electronic archive tapes for the duration of the project or a minimum of five years, whichever is longer.

8.6 PROJECT DATA FLOW AND TRANSFER

The data flow from the laboratory and field to the project staff and data users shall be sufficiently documented to ensure the data are properly tracked, reviewed, and validated for use.

8.7 RECORDKEEPING

The laboratory shall maintain electronic and hardcopy records sufficient to recreate each analytical event conducted pursuant to the SOW. The minimum records the laboratory shall keep contain the following: (1) COC forms, (2) initial and continuing calibration records including standards preparation traceable to the original material and lot number, (3) instrument tuning records (as applicable), (3) method blank results, (4) IS results, (5) surrogate spiking records and results (as applicable), (6) spike and spike duplicate records and results, (7) laboratory records, (8) raw data, including instrument printouts, bench work sheets, and/or chromatograms with compound

identification and quantitation reports, (9) corrective action reports, (10) other method and project required QC samples and results, and (11) laboratory-specific written SOPs for each analytical method and QA/QC function in place at the time of analysis of project samples.

8.8 HARDCOPY DATA REPORTS FOR SCREENING AND DEFINITIVE DATA

The hardcopy data reports shall conform to the formats identified in this section.

A screening data report package shall consist of the following AFCEE forms: COC, S-1, S-2, and S-3.

A definitive data inorganic report package shall consist of the following AFCEE forms: COC, I-1, I-2, I-3, I-4, I-5, I-6, I-7, I-8 and I-9 for each AAB with inorganic analyses performed.

A definitive data organic report package shall consist of the following AFCEE forms: COC, O-1, O-2, O-3 or O-3A, O-4, O-5 or O-5A, O-6, O-7, O-8, O-9 and O-10 for each AAB with organic analyses performed.

A definitive data wet chemistry report package shall consist of the following AFCEE forms: COC, W-1, W-2, W-3, W-4, W-5, W-6, W-7, W-8, and W-9 for each AAB with wet chemistry analyses performed.

Exceptions to these report forms are as follows: for mercury analysis, form I-3A shall be substituted for form I-3 in the inorganic report package; for cyanide analysis, form I-3B shall be substituted for form I-3 in the inorganic report package; for GC/MS analyses, forms O-3A and O-5A shall be used and form O-11 shall be added to the organic report package.

INSTRUCTIONS FOR COMPLETING AFCEE REPORT FORMS

The following instructions shall be used in completing the AFCEE report forms for screening and definitive data. The bold lettering identifies the fields on the AFCEE report form.

Use as many sheets as necessary. Sheets may be duplicated with only those sections necessary to be completed filled out (i.e., you do not have to duplicate previously reported information from one sheet to the next). Sequentially number the sheets at the bottom of the page if more than one sheet is necessary.

Reporting Dilutions Justification for diluting samples shall be provided in the comments section on the appropriate form (I-2, O-2 or W-2). If the result for any analyte is outside the calibration range (i.e., greater than the highest calibration standard), the sample shall be diluted appropriately and reanalyzed. Results from the undiluted and diluted sample shall be reported on the appropriate form (I-2, O-2 or W-2). The results of the analysis of the diluted sample shall be reported with the dilution noted on the report form and the MDL and RL adjusted for the dilution.

<u>ALL INORGANIC , ORGANIC AND WET CHEM FORMS</u>

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Lab Name: enter the laboratory name (e.g., Garland Labs, Inc.)

Contract #: enter the Air Force contract number and delivery order number under which the analytical work is being performed (e.g., F21625-94-D-8005/0001)

Comments: enter any comments

<u>FORM I-1</u>

Base/Command: enter the base name and the Air Force command (e.g., Banks AFB/ SPACECOM)

Prime Contractor: enter the name of the prime contractor (e.g., RDS, Inc)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

FORM I-1 (continued)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

FORM I-2

This form is completed for all environmental samples including the MD and MSD.

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

Matrix: enter the sample matrix (e.g., water, soil)

% Solids: enter the % solids

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the sample results

Date Received/Prepared/Analyzed: enter the appropriate dates in the format DD-MMM-YY (e.g., 3 Jun 96)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg dry weight)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

MDL: enter the laboratory derived method detection limit

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Concentration: enter the numeric result

Dilution: enter the dilution (if applicable) (e.g., 1:5)

Qualifier: enter the qualifier flag (see QAPP Sections 7 and 8)

<u>FORM I-3</u>

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Date of Initial Calibration: enter the appropriate date in the format DD-MMM-YY (e.g., 3 Jun 96)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

RF1, RF2, RF3: enter the response factor corresponding to the standard with the same number

Std 1, Std2, Std3: enter the concentration of the standard

r: enter the correlation coefficient

Q: enter a "*" for all corresponding correlation coefficients that were not acceptable as per QAPP Section 7

<u>FORM I-3A (Mercury analyses only)</u>

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Date of Initial Calibration: enter the appropriate date in the format DD-MMM-YY (e.g., 3 Jun 96)

Initial Calibration ID: enter the unique identifying number given to this initial calibration event

FORM I-3A (continued)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

RF1, RF2, RF3, RF4, RF5: enter the response factor corresponding to the standard with the same number

Std 1, Std 2, Std 3, Std 4, Std 5: enter the concentration of the standard

r: enter the correlation coefficient

Q: enter a "*" for all corresponding correlation coefficients that were not acceptable as per QAPP Section 7

FORM I-3B (Cyanide analyses only)

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Date of Initial Calibration: enter the appropriate date in the format DD-MMM-YY (e.g., 3 Jun 96)

Initial Calibration ID: enter the unique identifying number given to this initial calibration event
Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

RF1, RF2, RF3, RF4, RF5, RF6: enter the response factor corresponding to the standard with the same number

Std 1, Std 2, Std 3, Std 4, Std 5, Std 6: enter the concentration of the standard

r: enter the correlation coefficient

Q: enter a "*" for all corresponding correlation coefficients that were not acceptable as per QAPP Section 7

FORM I-3B (continued)

Expected: enter the expected result (i.e., the concentration of the calibration material).

Found: enter the measured result.

%D: enter the per cent difference between the expected and found

FORM I-4

AAB#: (optional) enter the unique AFCEE analytical batch number if these calibration events pertain to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the calibration verification results

2nd Source ID: enter the unique identifier for the 2nd source standard such that the standard could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., 2S960603)

CCV #1 ID: enter the unique identification number for the first CCV such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-1)

CCV #2 ID: enter the unique identification number for the second CCV such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-2)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

Expected: enter the expected result (i.e., the concentration of the calibration material).

Found, Found 1, Found 2: enter the measured result. Found 1 corresponds to the first CCV run, Found 2 corresponds to the second CCV run, etc.

<u>FORM I-4 (continued)</u>

%D: enter the per cent difference between the expected and found

Q: enter a "*" for any %D that was not acceptable as per QAPP Section 7

<u>FORM I-5</u>

AAB#: enter the unique AFCEE analytical batch number for the method blank (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Initial Calibration Blank ID: enter the identification number for the calibration blank (the same ID number will be found in the run sequence log, e.g., CB960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the initial calibration blank results

Method Blank ID: enter the unique identifying number given to the method blank (the same ID number will be found in the run sequence log, e.g., MB960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the method blank results

CCB #1 ID: (used for 6010B analysis) enter the identification number for the first CCB (the same ID number will be found in the run sequence log, e.g., CCB960603-1)

CCB #2 ID: (used for 6010B analysis) enter the identification number for the second CCB (the same ID number will be found in the run sequence log, e.g., CCB960603-2)

CCB #3 ID: (used for 6010B analysis) enter the identification number for the third CCB (the same ID number will be found in the run sequence log, e.g., CCB960603-3)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

Initial Calibration Blank: enter a numeric result for the calibration blank

Continuing Calibration Blank 1: enter a numeric result for the first continuing calibration blank run

FORM I-5 (continued)

Continuing Calibration Blank 2: enter a numeric result for the second continuing calibration blank run

Continuing Calibration Blank 3: enter a numeric result for the third continuing calibration blank run

Method Blank: enter a numeric result for the method blank

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Q: enter a "*" for any calibration or method blank analytes that were not acceptable as per QAPP
Section 7

FORM I-6

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

LCS ID: enter the unique identification number for the laboratory control sample such that the LCS could be traced back to its source material (the same ID number will be found in the run sequence log e.g., LCS960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the LCS results

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

Expected: enter the expected result (i.e., the concentration at which the analyte was spiked in LCS material)

Found: enter the measured result of the LSC analytes

%R: enter the per cent recovery

Control Limits: enter the control limits required to be met (see QAPP Section 7)

Q: enter a "*" for any %R that was not acceptable as per QAPP Section 7

FORM I-7

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

% Solids: enter the % solids of the parent field sample

Parent Field Sample ID: enter the field sample ID of the parent sample (the sample spiked for the MS and MSD)

MS ID: enter the unique identification number for the matrix spike such that the MS could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log e.g., MS960603)

MSD ID: enter the unique identification number for the matrix spike duplicate such that the MSD could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log e.g., MSD960603)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

Parent Sample Result: enter the numeric result of the parent sample. If an analyte was not detected above the MDL, leave this column blank

Spike Added: enter the amount of spike added to the parent sample

Spiked Sample Result: enter the numeric result of the MS

%R: enter the per cent recovery

Duplicate Spiked Sample Result: enter the numeric result of the MSD

%RPD: enter the relative per cent difference between the spike (MS) and spike duplicate (MSD)

Control Limits %R: enter the control limits required to be met (see QAPP Section 7)

Control Limits %RPD: enter the control limits required to be met (see QAPP Section 7)

Q: enter the qualifier flag as needed (see QAPP Sections 7 and 8)

FORM I-8

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Date Collected: enter the date the sample was taken in the field in the format DD-MMM-YY (e.g., 6 Jun 96)

Date Received: enter the date the sample was received at the laboratory in the format DD-MMM-YY (e.g., 6 Jun 96)

Date Analyzed: enter the date the sample was analyzed by the laboratory in the format DD-MMM-YY (e.g., 6 Jun 96)

Max. Holding Time: enter the maximum allowable holding time in days (see QAPP Section 5)

Time Held: enter the time in days elapsed between the date collected and the date analyzed

Q: enter a "*" for any holding times that were greater than the maximum allowable holding time as per QAPP Section 5

FORM I-9

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Field Sample ID/Std ID/Blank ID/QC Sample ID: enter the unique identifying number of each sample (environmental sample, standard, blank, LCS, MS, MSD, etc.) in the sequence they were analyzed

Date Analysis Started: enter the date the sample analysis was started in the format DD-MMM-YY (e.g., 6 Jun 96)

Time Analysis Started: enter the time the sample analysis was started in 24-hour format (e.g., 0900, 2130)

Date Analysis Completed: enter the date the sample analysis was completed in the format DD-MMM-YY (e.g., 6 Jun 96)

<u>FORM I-9 (continued)</u>

Time Analysis Completed: enter the time the sample analysis was completed in 24-hour format (e.g., 0900, 2130)

<u>FORM O-1</u>

Base/Command: enter the base name and the Air Force command (e.g., Banks AFB/ SPACECOM)

Prime Contractor: enter the name of the prime contractor (e.g., RDS, Inc)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

<u>FORM O-2</u>

This form is completed for all environmental samples including the MD and MSD.

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

Matrix: enter the sample matrix (e.g., water, soil)

% Solids: enter the % solids

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the sample results

Date Received/Prepared/Analyzed: enter the appropriate dates in the format DD-MMM-YY (e.g., 3 Jun 96)

<u>FORM O-2 (continued)</u>

Concentration Units: enter the appropriate units (i.e., µg/L or mg/kg dry weight)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

MDL: enter the laboratory derived method detection limit

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Concentration: enter the numeric result

Dilution: enter the dilution (if applicable) (e.g., 1:5)

Confirm: enter the numeric result from the confirmation column/detector

Qualifier: enter the qualifier flag as needed (see QAPP Section 7)

Surrogate: enter the name of the surrogate(s) used

Recovery: enter the per cent recovery of the surrogate

Control Limits: enter the control limits for the recovery of the surrogate (see QAPP section 7)

Internal Std: (used for 8260B and 8270C analysis) enter the name of the internal standard(s) used

<u>FORM O-3 and 3A</u>

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Date of Initial Calibration: enter the appropriate date in the format DD-MMM-YY (e.g., 3 Jun 96)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event

<u>FORM O-3 and 3A</u> (continued)

Concentration Units: enter the appropriate units (i.e., µg/L or mg/kg)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7. (On form 3A, some analyte names already appear on the form as provided, leave those analytes in that order.)

RF1, RF2, RF3, RF4, RF5, RF6, RF7: enter the response factor corresponding to the standard with the same number (RF6 and RF7 are used for non-linear calibrations)

Std 1, Std 2, Std 3, Std 4, Std 5, Std 6, Std 7: enter the concentration of the standard (Std 6 and Std 7 are used for non-linear calibrations)

%RSD: enter the per cent relative standard deviation of the response factors

Mean %RSD: enter the mean of the RSDs of all analytes for those analytes not using a least squares regression or non-linear calibration

r: (optional) if least squares regression is used for the calibration of an analyte, enter the correlation coefficient

COD: (optional) if a non-linear calibration is used for the calibration of an analyte, enter the coefficient of determination

Q: enter a "*" for any calibration that was not acceptable as per QAPP Section 7 and for any RFs not meeting minimum requirements for SPCCs and/or CCCs.

<u>FORM O-4</u>

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration event pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the second source calibration verification results

FORM O-4 (continued)

2nd Source ID: enter the unique identifier for the 2nd source standard such that the standard could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., 2S960603)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7.

Expected: enter the expected result (i.e., the concentration of the calibration material).

Found: enter the measured result.

%D: enter the per cent difference between the expected (i.e., the concentration of the second source calibration material) and measured result

Q: enter a "*" for any % D that was not acceptable as per QAPP Section 7

FORM O-5 and O-5A

AAB#: (optional) enter the unique AFCEE analytical batch number if these calibration events pertain to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the calibration verification results

ICV ID: enter the unique identification number for the ICV such that the ICV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., ICV960603-1)

CCV #1 ID: enter the unique identification number for the CCV run after the first 12 hours of operation such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-1)

CCV #2 ID: enter the unique identification number for the CCV run after the second 12 hours of

operation such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-2)

FORM O-5 and O-5A (continued)

Analyte: enter all analyte names in the same order as listed in the tables in QAPP Section 7. (On form O-5A, some analyte names already appear on the form as provided, leave those analytes in that order.)

RF: (form O-5A) enter the response factor for the SPCCs only

% D: enter the per cent difference

% D or % drift: (form O-5) enter the per cent difference if using RFs or % drift if using CFs

Q: enter a "*" for any % drift that was not acceptable as per requirements in QAPP Section 7

FORM O-6

AAB#: enter the unique AFCEE analytical batch number for the method blank (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Concentration Units: enter the appropriate units (i.e., µg/L or mg/kg)

Method Blank ID: enter the unique identification number for the method blank (the same ID number will be found in the run sequence log, e.g., MB960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the method blank results

Analyte: enter the name of the analyte (use the same name as used in the tables in Section 7 of the QAPP)

Method Blank: enter a numeric result for the method blank

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Q: enter a "*" for any method blank analyte result that was not acceptable as per QAPP Section 7

Surrogate: enter the name of the surrogate(s) used

Recovery: enter the per cent recovery of the surrogate

<u>FORM O-7</u>

Control Limits: enter the control limits for the recovery of the surrogate (see QAPP section 7)

Internal Std: (used for 8260B and 8270C analysis) enter the name of the internal standard(s) used

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

LCS ID: enter the unique identification number for the laboratory control sample such that the LCS could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., LCS960603)

Concentration Units: enter the appropriate units (i.e., µg/L or mg/kg)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the LCS results

Analyte: enter the name of the analyte (use the same name as used in the tables in Section 7 of the QAPP)

Expected: enter the expected result (i.e., the concentration at which the analyte was spiked in the LCS)

Found: enter the measured result of the LSC analytes

%R: enter the per cent recovery

Control Limits: enter the control limits required to be met (see QAPP Section 7)

Q: enter a "*" for any % R that was not acceptable as per QAPP Section 7

Surrogate: enter the name of the surrogate(s) used

Recovery: enter the per cent recovery of the surrogate

Internal Std: (used for 8260B and 8270C analysis) enter the name of the internal standard(s) used

FORM O-8

Concentration Units: enter the appropriate units (i.e., µg/L or mg/kg)

Parent Field Sample ID: enter the field sample ID of the parent sample (the sample spiked for the MS and MSD)

% Solids: enter the % solids

MS ID: enter the unique identification number for the matrix spike such that the MS could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log, e.g., MS960603)

MSD ID: enter the identification number for the matrix spike duplicate such that the MSD could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log, e.g., MSD960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the MS/MSD results

Analyte: enter the name of the analyte (use the same name as used in the tables in Section 7 of the QAPP)

Parent Sample Result: enter the result of the parent sample. If an analyte was not detected above the MDL, leave this column blank.

Spike Added: enter the amount of spike added to the parent sample

Spiked Sample Result: enter the numeric result of the MS

%R: enter the per cent recovery

Duplicate Spiked Sample Result: enter the numeric result of the MSD

%RPD: enter the relative per cent difference between the spike (MS) and spike duplicate (MSD)

Control Limits %R: enter the control limits required to be met (see QAPP Section 7)

Control Limits %RPD: enter the control limits required to be met (see QAPP Section 7)

Q: enter the qualifier flag as needed (see QAPP Sections 7)

<u>FORM O-9</u>

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Date Collected: enter the date the sample was taken in the field in the format DD-MMM-YY (e.g., 3 Jun 96)

Date Received: enter the date the sample was received at the laboratory in the format DD-MMM-YY (e.g., 3 Jun 96)

Date Extracted: enter the date the sample was extracted by the laboratory in the format DD-MMM-YY (e.g., 3 Jun 96)

Max. Holding Time E: enter the maximum allowable holding time in days until the sample is extracted (if applicable - see QAPP Section 5)

Time Held Ext.: enter the time in days elapsed between the date collected and the date extracted
(if applicable)

Date Analyzed: enter the date the sample was analyzed by the laboratory in the format DD-MMM-YY (e.g., 3 Jun 96)

Max. Holding Time A: enter the maximum allowable holding time in days until the sample is analyzed (see QAPP Section 5)

Time Held Anal.: enter the time in days elapsed between the date collected and the date analyzed

Q: enter a "*" for any holding time (Max. Holding Time E, or Max. Holding Time A, or Time Held Anal.) that was greater than the maximum holding time that was not acceptable as per QAPP Section 5

<u>FORM O-10</u>

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

FORM O-10 (continued)

Field Sample ID/Std ID/Blank ID/QC Sample ID: enter the unique identifying number of each sample (environmental sample, standard, blank, LCS, MS, MSD, etc.) in the sequence they were analyzed

Date Analysis Started: enter the date the sample analysis was started in the format DD-MMM-YY (e.g., 3 Jun 96)

Time Analysis Started: enter the time the sample analysis was started in 24-hour format (e.g., 0900, 2130)

Date Analysis Completed: enter the date the sample analysis was completed in the format DD-MMM-YY (e.g., 3 Jun 96)

Time Analysis Completed: enter the time the sample analysis was completed in 24-hour format (e.g., 0900, 2130)

FORM O-11

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Compound: enter BFB or DFTPP as appropriate

Injection Date/Time: enter the date (in the format DD-MMM-YY) and time (in 24-hour format) of the performance check

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the MS/MSD results

Mass: enter the mass of the ion used for tuning (see QAPP Section 7)

Ion Abundance Criteria: enter the criteria for the specific mass (see QAPP Section 7)

% Relative Abundance: enter the per cent relative abundance as the result of the tune

Q: enter a “*” for any % relative abundance results that was not acceptable as per QAPP Section 7

FORM W-1

Base/Command: enter the base name and the Air Force command (e.g., Banks AFB/ SPACECOM)

Prime Contractor: enter the name of the prime contractor (e.g., RDS, Inc)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

FORM W-2

This form is completed for all environmental samples including the MD and MSD.

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Lab Sample ID: enter the unique identifying number given to the sample by the laboratory that corresponds to the Field Sample ID

Matrix: enter the sample matrix (e.g., water, soil)

% Solids: enter the % solids

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the sample results

Date Received/Prepared/Analyzed: enter the appropriate dates in the format DD-MMM-YY (e.g., 3 Jun 96)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg dry weight)

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

FORM W-2 (continued)

MDL: enter the laboratory derived method detection limit

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Concentration: enter the numeric result

Dilution: enter the dilution (if applicable) (e.g., 1:5)

Qualifier: enter the qualifier flag (see QAPP Sections 7 and 8)

FORM W-3

AAB#: (optional) enter the unique AFCEE analytical batch number if this calibration pertains to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Date of Initial Calibration: enter the appropriate date in the format DD-MMM-YY (e.g., 3 Jun 96)

Initial Calibration ID: enter the unique identifying number given to this initial calibration event
Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

RF1, RF2, RF3: enter the response factor corresponding to the standard with the same number

Std 1, Std2, Std3: enter the concentration of the standard

r: enter the correlation coefficient

Q: enter a "*" for any correlation coefficients that were not acceptable as per QAPP Section 7

FORM W-4

AAB#: (optional) enter the unique AFCEE analytical batch number if these calibration events pertain to all the samples from one batch (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the calibration verification results

2nd Source ID: enter the unique identifier for the 2nd source standard such that the standard could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., 2S960603)

ICV ID: enter the unique identification number for the ICV such that the ICV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., ICV960603)

CCV #1 ID: enter the unique identification number for the first CCV such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-1)

CCV #2 ID: enter the unique identification number for the second CCV such that the CCV could be traced back to its source material (the same ID number will be found in the run sequence log, e.g., CCV960603-2)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

Expected: enter the expected result (i.e., the concentration of the calibration material)

Found, Found 1, Found 2: enter the measured result. Found 1 corresponds to the first CCV run, Found 2 corresponds to the second CCV run, etc.

%D: enter the per cent difference between the expected and found

Q: enter a “*” for any %D that was not acceptable as per QAPP Section 7

<u>FORM W-5</u>

AAB#: enter the unique AFCEE analytical batch number for the method blank (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Calibration Blank ID: enter the identification number for the calibration blank (the same ID number will be found in the run sequence log, e.g., CB960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the calibration blank results

Method Blank ID: enter the identification number for the method blank (the same ID number will be found in the run sequence log, e.g., MB960603)

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the method blank results

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

Calibration Blank: enter a numeric result for the calibration blank

Method Blank: enter a numeric result for the method blank

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Q: enter a "*" for any calibration or method blank analyte that was not acceptable as per QAPP Section 7

<u>FORM W-6</u>

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

LCS ID: enter the unique identification number for the laboratory control sample such that the LCS could be traced back to its source material (the same ID number will be found in the run sequence log e.g., LCS960603)

<u>FORM W-6 (continued)</u>

Initial Calibration ID: enter the unique identifying number given to the initial calibration event used in the determination of the LCS results

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

Expected: enter the expected result (i.e., the concentration at which the analyte was spiked in LCS material)

Found: enter the measured result of the LCS analyte

%R: enter the per cent recovery

Control Limits: enter the control limits required to be met (see QAPP Section 7)

Q: enter a "*" for any %R that was not acceptable as per QAPP Section 7

<u>FORM W-7</u>

% Solids: enter the % solids

Parent Field Sample ID: enter the field sample ID of the parent sample (the sample spiked for the MS and MSD)

MS ID: enter the unique identification number for the matrix spike such that the MS could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log e.g., MS960603)

MSD ID: enter the unique identification number for the matrix spike duplicate such that the MSD could be traced back to the source material used for spiking (the same ID number will be found in the run sequence log e.g., MSD960603)

Concentration Units: enter the appropriate units (i.e., mg/L or mg/kg)

Analyte: enter the name of the analytes (use the same name as used in the tables in Section 7 of the QAPP)

FORM W-7 (continued)

Parent Sample Result: enter the numeric result of the parent sample. If an analyte was not detected above the MDL, leave this column blank

Spike Added: enter the amount of spike added to the parent sample

Spiked Sample Result: enter the numeric result of the MS

%R: enter the per cent recovery

Duplicate Spiked Sample Result: enter the numeric result of the MSD

%RPD: enter the relative per cent difference between the spike (MS) and spike duplicate (MSD)

Control Limits %R: enter the control limits required to be met (see QAPP Section 7)

Control Limits %RPD: enter the control limits required to be met (see QAPP Section 7)

Q: enter the qualifier flag as needed (see QAPP Sections 7 and 8)

FORM W-8

AAB#: enter the unique AFCEE analytical batch number (see Section 4.4 of the AFCEE QAPP for a definition of a batch)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Date Collected: enter the date the sample was taken in the field in the format DD-MMM-YY (e.g., 6 Jun 96)

Date Received: enter the date the sample was received at the laboratory in the format DD-MMM-YY (e.g., 6 Jun 96)

Date Analyzed: enter the date the sample was analyzed by the laboratory in the format DD-MMM-YY (e.g., 6 Jun 96)

Max. Holding Time: enter the maximum allowable holding time in days (see QAPP Section 5)

Time Held: enter the time in days elapsed between the date collected and the date analyzed

FORM W-8 (continued)

Q: enter a "*" for any holding time that was greater than the maximum allowable holding time as per QAPP Section 5

FORM W-9

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Field Sample ID/Std ID/Blank ID/QC Sample ID: enter the unique identifying number of each sample (environmental sample, standard, blank, LCS, MS, MSD, etc.) in the sequence they were analyzed

Date Analysis Started: enter the date the sample analysis was started in the format DD-MMM-YY (e.g., 6 Jun 96)

Time Analysis Started: enter the time the sample analysis was started in 24-hour format (e.g., 0900, 2130)

Date Analysis Completed: enter the date the sample analysis was completed in the format DD-MMM-YY (e.g., 6 Jun 96)

Time Analysis Completed: enter the time the sample analysis was completed in 24-hour format (e.g., 0900, 2130)

FORM S-1

Base/Command: enter the base name and the Air Force command (e.g., Banks AFB/SPACECOM)

Prime Contractor: enter the name of the prime contractor (e.g., RDS, Inc)

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Signature: signature of person completing data package

Name: name of person completing data package

Date: enter the date the in the format DD-MMM-YY (e.g., 6 Jun 96)

<u>FORM S-1 (continued)</u>

Title: title of person completing data package

<u>FORM S-2</u>

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

Matrix: enter the sample matrix (e.g., water, soil)

Date Analyzed: enter the appropriate dates in the format DD-MMM-YY (e.g., 3 Jun 96)

Units: enter the appropriate units (e.g., µg/L, mg/kg, degrees C)

Analyte/Test: enter the name of the analyte or test performed (e.g., pH)

MDL: enter the method detection limit if applicable

RL: enter the project AFCEE reporting limit as stated in the QAPP or approved variance for each analyte

Result: enter the result

Qualifier: enter the qualifier needed (see QAPP Sections 7 and 8)

<u>FORM S-3</u>

Units: enter the appropriate units (e.g., µg/L, mg/kg, degrees C)

Analyte/Test: enter the name of the analyte or test performed (e.g., pH)

Sample Result: enter the result of the sample

Duplicate Sample Result: enter the result of the duplicate sample

%D or %RPD: enter the per cent or difference relative per cent difference between the sample and duplicate as appropriate

Acceptance Criteria: enter the acceptance criteria required to be met (see QAPP Section 6)

Q: enter a "*" for any % D or % RPD that was not acceptable as per QAPP Section 6

MDL FORM

Matrix: enter the sample matrix (e.g., water, soil)

Analysis Date: enter the date (or inclusive dates if performed over a period of days) the MDL was performed in the format DD-MMM-YY (e.g., 6 Jun 96)

Instrument ID: enter the instrument identifier (e.g., the serial number or other identifying number/name)

Analyte: enter the name of the analyte (use the same name as used in the tables in Section 7 of the QAPP)

Amt. Spiked: enter the amount of spike added to the matrix

Replicate 1,2,3,4,5,6,7: enter the result of the replicate

Std. Dev.: enter the standard deviation of the seven replicates

MDL: enter the calculated MDL

CHAIN OF CUSTODY FORM

COC#: enter a unique number for each chain of custody form

Ship to: enter the laboratory name and address

Carrier: enter the name of the transporter (e.g., FedEx) or handcarried

Airbill#: enter the airbill number or transporter tracking number (if applicable)

Project Name: enter the project name (e.g., Banks AFB RI/FS)

Sampler Name: enter the name of the person collecting the samples

Sampler Signature: signature of the person collecting the samples

Send Results to: enter the name and address of the prime contractor

Field Sample ID: enter the unique identifying number given to the field sample (includes MS, MSD, field duplicate and field blanks)

CHAIN OF CUSTODY FORM (continued)

Date: enter the year and date the sample was collected in the format M/D (e.g., 6/3)

Time: enter the time the sample was collected in 24-hour format (e.g., 0900)

Matrix: enter the sample matrix (e.g., water, soil)

Pres: enter the preservative used (e.g., HNO3) or "none"

Filtered/Unfilt.: enter "F" if the sample was filtered or "U" if the sample was not filtered

# of Containers: enter the number of containers (i.e., jars, bottles) associated with the sample

MS/MSD: enter "X" if the sample is designated the MD/MSD

Analyses Requested: enter the method name of the analysis requested (e.g., SW6010B)

Comments: enter comments

Sample Condition Upon Receipt at Laboratory: enter any problems with the condition of any sample(s)

Cooler Temperature: enter the internal temperature of the cooler, upon opening, in degrees C

Special Instructions/Comments: enter any special instructions or comments

Released by: (SIG): enter the signature of the person releasing custody of the samples

Company Name: enter the company name employing the person releasing/receiving custody

Received by: (SIG): enter the signature of the person receiving custody of the samples

Date: enter the date in the format M/D/YY (e.g., 6/3/96) when the samples were released/ received

Time: enter the time in 24-hour format (e.g., 0900) when the samples were released/received

AFCEE
INORGANIC ANALYSES DATA PACKAGE

Analytical Method: ________________ AAB #: _________________

Lab Name: __________________________ Contract #: _______________________

Base/Command: _________________ Prime Contractor: __________________________________

Field Sample ID	Lab Sample ID
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Comments:
____
____
____

I certify this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: ____________________________ Name: _________________________________

Date: ____________________________ Title: _________________________________

AFCEE FORM I-1

AFCEE
INORGANIC ANALYSES DATA SHEET 2
RESULTS

Analytical Method: ________________ Preparatory Method: _______________ AAB #: __________________

Lab Name: _______________________________ Contract #: _____________________________

Field Sample ID: ___________________ Lab Sample ID: ___________________ Matrix: __________

% Solids: __________ Initial Calibration ID: _______________________

Date Received: ________________ Date Prepared: _________________ Date Analyzed: __________________

Concentration Units (mg/L or mg/kg dry weight): ________________

Analyte	MDL	RL	Concentration	Dilution	Qualifier

Comments:

____
____
____
____

AFCEE FORM I-2 Page ___ of _____

AFCEE
INORGANIC ANALYSES DATA SHEET 3
INITIAL MULTIPOINT CALIBRATION

Analytical Method: ________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Date of Initial Calibration: _____________ Initial Calibration ID: _______________

Instrument ID: _____________ Concentration Units (mg/L or mg/kg): _____________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	r	Q

r = correlation coefficient

Comments:

____

____

____

AFCEE FORM I-3

AFCEE
INORGANIC ANALYSES DATA SHEET 3
MERCURY INITIAL MULTIPOINT CALIBRATION

Analytical Method: _________________ AAB #: _______________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID: ____________________ Date of Initial Calibration: _______________

Initial Calibration ID: __________________ Concentration Units (mg/L or mg/kg): _________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	Std 4	RF 4	Std 5	RF 5	r	Q
Mercury												

r = correlation coefficient

Comments:
___
___
___

AFCEE
INORGANIC ANALYSES DATA SHEET 3
CYANIDE INITIAL MULTIPOINT CALIBRATION

Analytical Method: ________________ AAB #: ______________________

Lab Name: ____________________________ Contract #: __________________________

Instrument ID: ___________________ Date of Initial Calibration: ______________

Initial Calibration ID: ________________ Concentration Units (mg/L or mg/kg): __________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	Std 4	RF 4	Std 5	RF 5	Std 6	RF 6	r	Q
Cyanide														

r = correlation coefficient

	Expected	Found	%D	Q
High Distilled Standard				
Low Distilled Standard				

Comments:
____
____
____

AFCEE
INORGANIC ANALYSES DATA SHEET 4
CALIBRATION VERIFICATION

Analytical Method: ____________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: _____________________ Initial Calibration ID: ________________

2nd Source ID: ______________ ICV ID: _________________

CCV #1 ID: _________________ CCV #2 ID: __________________

Concentration Units (mg/L or mg/kg): ______________

Analyte	2nd Source Calibration Verification			Initial Calibration Verification			Continuing Calibration Verification					Q
	Expected	Found	%D	Expected	Found	%D	Expected	Found 1	%D	Found 2	%D	

Comments:
____
____
____

AFCEE
INORGANIC ANALYSES DATA SHEET 5
BLANKS

Analytical Method: __________________ AAB #: ____________________

Lab Name: _____________________________ Contract #: ___________________________

Concentration Units (mg/L or mg/kg): _____________

Initial Calibration Blank ID: _______________ Initial Calibration ID: __________________

CCB #1 ID: ______________ CCB #2 ID: ______________ CCB #3 ID: ______________

Method Blank ID: ________________ Initial Calibration ID: ______________________

Analyte	Initial Calibration Blank	Continuing Calibration Blank			Method Blank	RL	Q
		1	2	3			

Comments:
____
____
____

AFCEE
INORGANIC ANALYSES DATA SHEET 6
LABORATORY CONTROL SAMPLE

Analytical Method: __________________ AAB #: ___________________

Lab Name: _____________________________ Contract #: ___________________________

LCS ID: ___________________ Initial Calibration ID: _______________

Concentration Units (mg/L or mg/kg): _____________

Analyte	Expected	Found	%R	Control Limits	Q

Comments:
____
____
____

AFCEE
INORGANIC ANALYSES DATA SHEET 7
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLE RECOVERY

Analytical Method: ________________

Lab Name: ______________________________ Contract #: ____________________________

Concentration Units (mg/L or mg/kg): _____________ % Solids: __________

Parent Field Sample ID: _______________ MS ID: ________________ MSD ID: ________________

Analyte	Parent Sample Result	Spike Added	Spiked Sample Result	%R	Duplicate Spiked Sample Result	%R	%RPD	Control Limits %R	Control Limits %RPD	Q

Comments:
____
____
____

AFCEE FORM I-7

AFCEE
INORGANIC ANALYSES DATA SHEET 8
HOLDING TIMES

Analytical Method: ___________________ AAB #: ___________________

Lab Name: ______________________________ Contract #: ____________________________

Field Sample ID	Date Collected	Date Received	Date Analyzed	Max. Holding Time (days)	Time Held (days)	Q

Comments:
___
___
___

AFCEE
INORGANIC ANALYSES DATA SHEET 9
INSTRUMENT ANALYSIS SEQUENCE LOG

Analytical Method: ___________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID #: ________________

Field Sample ID/Std ID/ Blank ID/QC Sample ID	Date Analysis Started	Time Analysis Started	Date Analysis Completed	Time Analysis Completed

Comments:
____
____
____

AFCEE FORM I-9 Page ___ of _____

AFCEE
ORGANIC ANALYSES DATA PACKAGE

Analytical Method: ________________ AAB #: _________________

Lab Name: __________________________ Contract #: _______________________

Base/Command: _________________ Prime Contractor: __________________________________

Field Sample ID	Lab Sample ID
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Comments:
____
____
____

I certify this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: ____________________________ Name: _________________________________

Date: ____________________________ Title: _________________________________

AFCEE FORM O-1

AFCEE
ORGANIC ANALYSES DATA SHEET 2
RESULTS

Analytical Method: _______________ Preparatory Method: ______________ AAB #: _________________

Lab Name: _____________________________ Contract #: ___________________________

Field Sample ID: __________________ Lab Sample ID: __________________ Matrix: _________

% Solids: _________ Initial Calibration ID: _______________

Date Received: _______________ Date Prepared: ________________ Date Analyzed: _________________

Concentration Units (ug/L or mg/kg dry weight): _______________

Analyte	MDL	RL	Concentration	Dilution	Confirm	Qualifier

Surrogate	Recovery	Control Limits	Qualifier

Internal Std	Qualifier

Comments:
____
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 3A
INITIAL MULTIPOINT CALIBRATION-GC/MS ANALYSIS

Analytical Method: _________________ AAB #: ______________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID: ____________________ Date of Initial Calibration: _______________

Initial Calibration ID: ___________________ Concentration Units (ug/L or mg/kg): _______________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	Std 4	RF 4	Std 5	RF 5	Std 6	RF 6	Std 7	RF 7
Chloromethane *														
1,1-DCA *														
Bromoform *														
Chlorobenzene *														
1,1,2,2-TCA *														
1,1-DCE #														
Chloroform #														
1,2-DCP #														
Toluene #														
Ethylbenzene #														
Vinyl chloride #														

* SPCCs # CCCs

Comments:

____

____

____

AFCEE
ORGANIC ANALYSES DATA SHEET 3A
INITIAL MULTIPOINT CALIBRATION-GC/MS ANALYSIS

Analytical Method: ________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: ____________________ Date of Initial Calibration: _______________

Initial Calibration ID: ___________________ Concentration Units (ug/L or mg/kg): _______________

Analyte	% RSD	mean %RSD	r	COD	Q
Chloromethane *					
1,1-DCA *					
Bromoform *					
Chlorobenzene *					
1,1,2,2-TCA *					
1,1-DCE #					
Chloroform #					
1,2-DCP #					
Toluene #					
Ethylbenzene #					
Vinyl chloride #					

* SPCCs # CCCs

Comments:

____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 3
INITIAL MULTIPOINT CALIBRATION-GC/MS ANALYSIS

Analytical Method: _________________ AAB #: ______________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID: ____________________ Date of Initial Calibration: _______________

Initial Calibration ID: ___________________ Concentration Units (ug/L or mg/kg): _______________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	Std 4	RF 4	Std 5	RF 5	Std 6	RF 6	Std 7	RF 7

Comments:
____
____
____

AFCEE FORM O-3 Page ___ of _____

AFCEE
ORGANIC ANALYSES DATA SHEET 3
INITIAL MULTIPOINT CALIBRATION-GC/MS ANALYSIS

Analytical Method: _________________ AAB #: ______________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID: ____________________ Date of Initial Calibration: _______________

Initial Calibration ID: ___________________ Concentration Units (ug/L or mg/kg): _______________

Analyte	% RSD	mean %RSD	r	COD	Q

Comments:
____
____
____

AFCEE FORM O-3 Page ___ of _____

AFCEE
ORGANIC ANALYSES DATA SHEET 4
SECOND SOURCE CALIBRATION VERIFICATION

Analytical Method: ____________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: __________________ Initial Calibration ID: ______________

2nd Source ID: ______________ Concentration Units (ug/L or mg/kg): ________________

Analyte	Expected	Found	%D	Q

Comments:
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 5A
CALIBRATION VERIFICATION-GC/MS ANALYSIS

Analytical Method: ____________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: ____________ Initial Calibration ID: _________________

ICV ID: _____________ CCV #1 ID: ________________ CCV #2 ID: _________________

	ICV		CCV #1		CCV #2		
Analyte	RF	% D	RF	% D	RF	% D	Q
Chloromethane *							
1,1-DCA *							
Bromoform *							
Chlorobenzene *							
1,1,2,2-TCA *							
1,1-DCE #							
Chloroform #							
1,2-DCP #							
Toluene #							
Ethylbenzene #							
Vinyl chloride #							

* SPCCs # CCCs

Comments:
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 5
CALIBRATION VERIFICATION

Analytical Method: ____________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: ____________ Initial Calibration ID: _________________

ICV ID: _____________ CCV #1 ID: ________________ CCV #2 ID: _________________

Analyte	ICV %D or % drift	CCV#1 %D or % drift	CCV#2 %D or % drift	Q

Comments:
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 6
BLANK

Analytical Method: __________________ AAB #: ____________________

Lab Name: ______________________________ Contract #: ____________________________

Concentration Units (ug/L or mg/kg): ________________ Method Blank ID: ________________

Initial Calibration ID: _______________

Analyte	Method Blank	RL	Q

Surrogate	**Recovery**	**Control Limits**	**Qualifier**

Internal Std	**Qualifier**

Comments:
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 7
LABORATORY CONTROL SAMPLE

Analytical Method: __________________ AAB #: ___________________

Lab Name: _____________________________ Contract #: ___________________________

LCS ID: ___________________ Initial Calibration ID: _______________

Concentration Units (ug/L or mg/kg): _______________

Analyte	Expected	Found	%R	Control Limits	Q

Surrogate	**Recovery**	**Control Limits**	**Qualifier**

Internal Std	**Qualifier**

Comments:

____

____

____

AFCEE
ORGANIC ANALYSES DATA SHEET 8
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLE RECOVERY

Analytical Method: ________________

Lab Name: ______________________________ Contract #: ___________________________

Concentration Units (ug/L or mg/kg): _______________ % Solids: __________

Parent Field Sample ID: _______________ MS ID: ________________ MSD ID: __________________

Analyte	Parent Sample Result	Spike Added	Spiked Sample Result	%R	Duplicate Spiked Sample Result	%R	%RPD	Control Limits %R	Control Limits %RPD	Q

Comments:
____
____
____

AFCEE FORM O-8 Page ___ of _____

AFCEE
ORGANIC ANALYSES DATA SHEET 9
HOLDING TIMES

Analytical Method: __________________ AAB #: __________________

Lab Name: ______________________________ Contract #: ____________________________

Field Sample ID	Date Collected	Date Received	Date Extracted	Max. Holding Time E	Time Held Ext.	Date Analyzed	Max. Holding Time A	Time Held Anal.	Q

Comments:
____
____
____

AFCEE
ORGANIC ANALYSES DATA SHEET 10
INSTRUMENT ANALYSIS SEQUENCE LOG

Analytical Method: ___________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID #: ________________

Field Sample ID/Std ID/ Blank ID/QC Sample ID	Date Analysis Started	Time Analysis Started	Date Analysis Completed	Time Analysis Completed

Comments:

____

____

____

AFCEE
ORGANIC ANALYSES DATA SHEET 11
INSTRUMENT PERFORMANCE CHECK
(BFB or DFTPP)

Analytical Method: ________________

Lab Name: ____________________________ Contract #: __________________________

Instrument ID: ______________ Compound: _______ Injection Date/Time: _________________

Initial Calibration ID: _______________

Mass	Ion Abundance Criteria	% Relative Abundance	Q

AFCEE
WET CHEM ANALYSES DATA PACKAGE

Analytical Method: ________________ AAB #: _________________

Lab Name: __________________________ Contract #: _______________________

Base/Command: _________________ Prime Contractor: __________________________________

Field Sample ID	Lab Sample ID
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________
____________	____________

Comments:
____
____
____

I certify this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: ____________________________ Name: _________________________________

Date: ____________________________ Title: _________________________________

AFCEE FORM W-1

AFCEE
WET CHEM ANALYSES DATA SHEET 2
RESULTS

Analytical Method: ________________ AAB #: __________________

Lab Name: _______________________________ Contract #: _____________________________

Field Sample ID: ___________________ Lab Sample ID: ___________________ Matrix: _________

% Solids: _________ Initial Calibration ID: ________________

Date Received: ________________ Date Prepared: _________________ Date Analyzed: __________________

Concentration Units (mg/L or mg/kg dry weight): ________________

Analyte	**MDL**	**RL**	**Concentration**	**Dilution**	**Qualifier**

Comments:
____
____
____
____

AFCEE
WET CHEM ANALYSES DATA SHEET 3
INITIAL MULTIPOINT CALIBRATION

Analytical Method: _________________ AAB #: ______________________

Lab Name: ______________________________ Contract #: ____________________________

Instrument ID: ________________ Date of Initial Calibration: _______________

Initial Calibration ID: _______________ Concentration Units (mg/L or mg/kg): _______________

Analyte	Std 1	RF 1	Std 2	RF 2	Std 3	RF 3	r	Q

r = correlation coefficient

Comments:

____

____

____

AFCEE
WET CHEM ANALYSES DATA SHEET 4
CALIBRATION VERIFICATION

Analytical Method: ___________________ AAB #: _____________________

Lab Name: _____________________________ Contract #: ___________________________

Instrument ID: ____________________ Initial Calibration ID: _______________

2nd Source ID: _____________ CCV #1 ID: ________________ CCV #2 ID: _________________

Analyte	2nd Source Calibration Verification			Continuing Calibration Verification					Q
	Expected	Found	%D	Expected	Found 1	%D	Found 2	%D	

Comments:
____
____
____

AFCEE FORM W-4

AFCEE
WET CHEM ANALYSES DATA SHEET 5
BLANKS

Analytical Method: __________________ AAB #: ____________________

Lab Name: _____________________________ Contract #: ___________________________

Concentration Units (mg/L or mg/kg): _______________

Calibration Blank ID: _______________ Initial Calibration ID: _______________

Method Blank ID: ________________ Initial Calibration ID: _______________

Analyte	Calibration Blank	Method Blank	RL	Q

Comments:
____
____
____

AFCEE FORM W-5

AFCEE
WET CHEM ANALYSES DATA SHEET 6
LABORATORY CONTROL SAMPLE

Analytical Method: __________________ AAB #: ___________________

Lab Name: _____________________________ Contract #: ___________________________

LCS ID: ___________________ Initial Calibration ID: _______________

Concentration Units (mg/L or mg/kg): _______________

Analyte	Expected	Found	%R	Control Limits	Q

Comments:

AFCEE FORM W-6

AFCEE
WET CHEM ANALYSES DATA SHEET 7
MATRIX SPIKE/MATRIX SPIKE DUPLICATE SAMPLE RECOVERY

Analytical Method: ________________ AAB #: _________________

Lab Name: ______________________________ Contract #: ____________________________

% Solids: __________ Initial Calibration ID: _______________

Parent Field Sample ID: _______________ MS ID: ________________ MSD ID: ______________

Concentration Units (mg/L or mg/kg): _______________

Analyte	Parent Sample Result	Spike Added	Spiked Sample Result	%R	Duplicate Spiked Sample Result	%R	%RPD	Control Limits %R	Control Limits %RPD	Q

Comments:

____

____

____

AFCEE FORM W-7

AFCEE
WET CHEM ANALYSES DATA SHEET 8
HOLDING TIMES

Analytical Method: __________________ AAB #: __________________

Lab Name: ______________________________ Contract #: ____________________________

Field Sample ID	Date Collected	Date Received	Date Analyzed	Max. Holding Time (days)	Time Held (days)	Q

Comments:

AFCEE
WET CHEM ANALYSES DATA SHEET 9
INSTRUMENT ANALYSIS SEQUENCE LOG

Analytical Method: ___________________

Lab Name: _____________________________   Contract #: ___________________________

Instrument ID #: ________________

Field Sample ID/Std ID/ Blank ID/QC Sample ID	Date Analysis Started	Time Analysis Started	Date Analysis Completed	Time Analysis Completed

Comments:
____
____
____

AFCEE
SCREENING DATA PACKAGE

Analytical Method: ________________ Contract #: _______________________

Base/Command: _________________ Prime Contractor: __________________________________

Field Sample ID

______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________
______________ ______________

Comments:
____
____
____

Signature: ____________________________ Name: _________________________________

Date: ____________________________ Title: _________________________________

AFCEE FORM S-1

AFCEE
SCREENING DATA SHEET 2
RESULTS

Analytical Method: _______________

Contract #: ___________________________ Field Sample ID: __________________

Matrix: _________ Date Analyzed: _________________

Concentration Units (ug/L, mg/kg dry weight or ^{o}C): _______________

Analyte/Test	MDL	RL	Result	Qualifier

Comments:

____

____

____

____

AFCEE
SCREENING DATA SHEET 3
FIELD DUPLICATES

Analytical Method: ________________ Contract #: ___________________________

Units: ____________

Analyte/Test	Sample Result	Duplicate Sample Result	%D or %RPD	Acceptance Criteria	Q

Comments:
____
____
____

AFCEE FORM S-3 Page ___ of _____

MDL STUDY REPORT FORM

Lab Name: ____________________ Analytical Method: ____________________ Matrix: ____________

Analysis Date: __________________ Instrument ID: _____________________

Concentration Units (mg/L or mg/kg): _______________

Analyte	Amt. Spiked	Replicate							Std. Dev.	MDL
		1	2	3	4	5	6	7		

AFCEE
CHAIN OF CUSTODY RECORD

COC#: ________________

Ship to:	Project Name:	Send Results to:
	Sampler Name:	
Carrier: Airbill #:	Sampler Signature:	

Field Sample ID	Date 19__	Time	Matrix	Pres	Filtered/ Unfilt.	# of Containers	MS/ MSD	Analyses Requested											Comments

Sample Condition Upon Receipt at Laboratory:	Cooler temperature:
Special Instructions/Comments:	

#1 Released by: (Sig)	Date:	#2 Released by: (Sig)	Date:	#3 Released by: (Sig)	Date:
Company Name:	Time	Company Name:	Time	Company Name:	Time
#1 Received by: (Sig)	Date	#2 Received by: (Sig)	Date	#3 Received by: (Sig)	Date
Company Name:	Time:	Company Name:	Time:	Company Name:	Time:

9.0 SYSTEMS AND PERFORMANCE AUDITS, PERFORMANCE EVALUATION PROGRAMS, MAGNETIC TAPE AUDITS, AND TRAINING

Technical systems and performance audits shall be performed as independent assessments of sample collection and analysis procedures. Audit results will be used to evaluate the ability of an analytical contractor to (1) produce data that fulfill the objectives established for the program, (2) comply with the QC criteria, and (3) identify any areas requiring corrective action. The systems audit is a qualitative review of the overall sampling or measurement system, while the performance audit is a quantitative assessment of a measurement system. Audit guidance can be found in the *HQ AFCEE Technical Services Quality Assurance Program*, current version. Full data validation is also a quantitative check of the analytical process, where all documentation and calculations are evaluated and verified. Data validation is discussed in Section 8.

9.1 PROJECT AUDITS

9.1.1 State/Federal Project Audits

Audits by various state and federal agencies are commonly conducted for the laboratories that will analyze project samples. Audit reports from these agencies shall be reviewed by the prime contractor to determine whether data produced by the analytical contractor shall fulfill the objectives of the program.

Audit findings shall be transmitted form the laboratory to the prime contractor and to AFCEE. The prime contractor shall review the audit findings and provide a written report to AFCEE. This report shall include the recommended corrective actions or procedures to correct the deficiencies identified during the state/federal audits(s). The audit results and discussion shall be incorporated into the QA report for each sampling effort.

9.1.2 Technical Systems Audits

A technical systems audit is an on-site, qualitative review of the sampling or analytical system to ensure that the activity is being performed in compliance with the Sampling and Analysis Plan (SAP) specifications. Sampling and field procedures, and the analytical laboratories shall be audited by the prime contractor at the beginning of the project. In addition, a laboratory systems audit may be performed by AFCEE if previous audit reports indicate corrective actions are outstanding, a recent audit has not been conducted, or quality concerns have arisen based upon the use of that laboratory for other projects. The laboratory systems audit results will be used to assess the prime contractor’s oversight and to review laboratory operation and ensure the technical procedures and documentation are in place and operating to provide data that fulfill the project objectives and to ensure outstanding corrective actions have been addressed.

Critical items for a laboratory or field systems audit include: (1) sample custody procedures, (2) calibration procedures and documentation, (3) completeness of data forms, notebooks, and other reporting requirements, (4) data review and validation procedures, (5) data storage, filing, and record keeping procedures, (6) QC procedures, tolerances, and documentation, (7) operating conditions of facilities and equipment, (8) documentation of training and maintenance activities, (9) systems and operations overview, and (10) security of laboratory automated systems.

Critical items for a sampling systems audit include: (1) calibration procedures and documentation for field equipment, (2) documentation in field logbooks and sampling data sheets, (3) organization and minimization of potential contamination sources while in the field, (4) proper sample collection, storage, and transportation procedures, and (5) compliance with established COC and transfer procedures.

After each on-site audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit an audit report including observations of the deficiencies and the necessary recommendations for corrective actions to the prime contractor. Compliance with the specifications presented in the SAP will be noted and noncompliance or deviations shall be addressed in writing by the prime contractor to AFCEE with corrective actions and a time frame for implementation of the corrective actions. Follow-up audits will be performed prior to completion of the project to ensure corrective actions have been taken.

9.1.3 Project-Specific Performance Evaluation Audits

Performance audits quantitatively assess the data produced by a measurement system. A performance audit involves submitting project-specific performance evaluation (PE) samples for analysis for each analytical method used in the project. The prime contractor shall submit project specific PE samples once per quarter per project. The project-specific PE samples are selected to reflect the expected range of concentrations for the sampling program. The performance audit answers questions about whether the measurement system is operating within control limits and whether the data produced meet the analytical QA specifications.

The project-specific PE samples are made to look as similar to field samples as possible and are submitted as part of a field sample shipment so that the laboratory is unable to distinguish between them and project samples. This approach ensures unbiased sample analysis and reporting by the laboratory.

The critical elements for review of PE results include: (1) correct identification and quantitation of the PE sample analytes, (2) accurate and complete reporting of the results, and (3) measurement system operation within established control limits for precision and accuracy.

The concentrations reported for the PE samples shall be compared to the known or expected concentrations spiked in the samples. The percent recovery shall be calculated and the results

assessed according to the accuracy criteria for the LCS presented in Section 7. If the accuracy criteria are not met, the cause of the discrepancy shall be investigated and a second PE sample shall be submitted. The prime contractor shall notify the project staff, AFCEE, and agencies of the situation at the earliest possible time and the prime contractor shall keep AFCEE up to date regarding corrective actions and subsequent PE sample results.

9.1.4 Magnetic Tape Audits

Magnetic tape audits involve the examination of the electronic media used by the analytical laboratory and by the prime contractor to collect, analyze, report, and store data. These audits are used to assess the authenticity of the data generated, and assess the implementation of good automated laboratory practices. AFCEE may perform magnetic tape audits of the laboratories or of the prime contractors when warranted by project PE results, on-site audit results, or by other state/federal investigations.

9.1.5 Performance Evaluation Sample Programs

All laboratories shall participate in the U.S. EPA PE Water Supply and Water Pollution Studies programs or equivalent programs for state certifications. Satisfactory performance in these nonproject-specific PE programs also demonstrate proficiency in methods used to analyze AFCEE samples. The laboratory shall document the corrective actions to unacceptable PE results to demonstrate resolution of the problems.

9.2 TRAINING

Training shall be provided to all project personnel to ensure compliance with the health and safety plan and technical competence in performing the work effort. Documentation of this training shall be maintained in the records of the contracted organizations.

This page intentionally left blank.

10.0 PREVENTIVE MAINTENANCE

A preventive maintenance program shall be in place to promote the timely and effective completion of a measurement effort. The preventive maintenance program is designed to minimize the downtime of crucial sampling and/or analytical equipment due to unexpected component failure. In implementing this program, efforts are focused in three primary areas: (1) establishment of maintenance responsibilities, (2) establishment of maintenance schedules for major and/or critical instrumentation and apparatus, and (3) establishment of an adequate inventory of critical spare parts and equipment.

10.1 MAINTENANCE RESPONSIBILITIES

Maintenance responsibilities for equipment and instruments are assumed by the respective facility managers. The managers then establish maintenance procedures and schedules for each major equipment item. This responsibility may be delegated to laboratory personnel, although the managers retain responsibility for ensuring adherence to the prescribed protocols.

10.2 MAINTENANCE SCHEDULES

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. Other maintenance activities are conducted as needed. Manufacturers' recommendations provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/mass spectrometry instruments, AA spectrometers, and analytical balances).

10.3 SPARE PARTS

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment downtime. The inventory includes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

Field sampling task leaders and the respective laboratory managers are responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and supply inventories, the contractor shall maintain an in-house source of backup equipment and instrumentation.

10.4 MAINTENANCE RECORDS

Maintenance and repair of major field and laboratory equipment shall be recorded in field or laboratory logbooks. These records shall document the serial numbers of the equipment, the

person performing the maintenance or repairs, the date of the repair, the procedures used during the repair, and proof of successful repair prior to the use of the equipment.

11.0 CORRECTIVE ACTION

Corrective actions, if necessary, shall be completed once. If acceptance criteria were not met and a corrective action was not successful or corrective action was not performed, apply the appropriate flagging criteria. Requirements and procedures for documenting the need for corrective actions are described in this section.

11.1 CORRECTIVE ACTION REPORT

Problems requiring corrective action in the laboratory shall be documented by the use of a corrective action report. The QA coordinator or any other laboratory member can initiate the corrective action request in the event QC results exceed acceptability limits, or upon identification of some other laboratory problem. Corrective actions can include reanalysis of the sample or samples affected, resampling and analysis, or a change in procedures, depending upon the severity of the problem.

11.2 CORRECTIVE ACTION SYSTEM

A system for issuing, tracking, and documenting completion of formal Recommendations for Corrective Action (RCA) exists for addressing significant and systematic problems. Recommendations for corrective actions are issued only by a member of the QA group, or a designee in a specific QA role. Each RCA addresses a specific problem or deficiency, usually identified during QA audits of laboratory or project operations. An RCA requires a written response from the party to whom the RCA was issued. A summary of unresolved RCAs is included in the monthly QA report to management. The report lists all RCAs that have been issued, the manager responsible for the work area, and the current status of each RCA. An RCA requires verification by the QA group that the corrective action has been implemented before the RCA is considered to be resolved. In the event there is no response to an RCA within 30 days, or if the proposed corrective action is disputed, the recommendation and/or conflict is pursued to successively higher management levels until the issue is resolved.

This page intentionally left blank.

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

At a minimum, the QA coordinator of the laboratory shall prepare a summary report quarterly of the status of the project, of QA/QC problems, corrective actions taken, and unresolved RCAs with recommended solutions for management. The report shall also include results from all PE samples, audit findings, and periodic data quality assessments. This report shall be available for review by AFCEE auditors upon request.

Construction Quality Assurance Plan for ESTCP Project 200020

PIMS-Remediation of Soil Contaminated with Lead at Camp Stanley Storage Activity, TX

Work to be Performed by

UFA Ventures, Inc. and

Los Alamos National Laboratory

for

Camp Stanley Storage Activity
25800 Ralph Fair Road
Boerne, TX 78015-4800
June 2001

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

CQA	Construction quality assurance
CSSA	Camp Stanley Storage Activity
ESTCP	Environmental Security Technology Certification Program
HDPE	High density polyethylene
LCS	Leachate collection system
PIMS	Phosphate induced metals stabilization

SECTION 1
INTRODUCTION

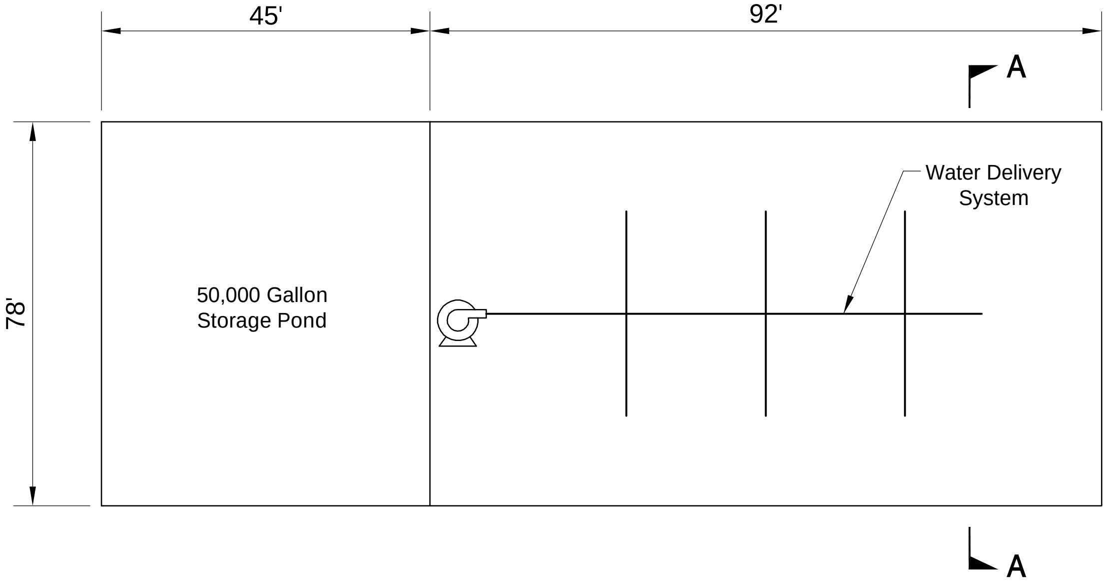
This construction quality assurance (CQA) plan for a field test cell at Camp Stanley Storage Activity (CSSA) in Boerne, Texas, has been prepared to provide guidelines for the implementation of CQA during construction of a field test cell for demonstrating the efficacy of a Phosphate Induced Metals Stabilization (PIMS) treatment system. This CQA plan describes the construction of a test cell located at CSSA which is being conducted as part of UFA Ventures, Inc. field demonstration study funded by the Environmental Security Technology Certification Program (ESTCP) project number 200020. The inspections outlined in this plan will be at the expense of UFA Ventures, Inc.

1.1 TEST CELL DESCRIPTION

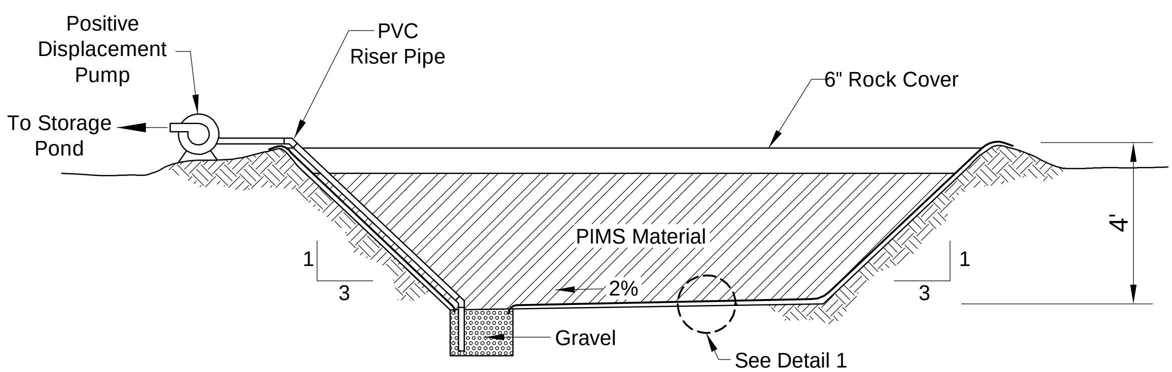
The test cell will be approximately 75 feet x 50 feet and located in the inner cantonment of CSSA. The test cell will be lined with a composite membrane liner and include a leachate collection system. The leachate collection system will include a geonet drainage medium, collection pipes, and a sump with a withdrawal system. The construction of the test cell will begin in April 2001. The test cell is estimated to hold in excess of 500 cubic yards of treated soil media when completely filled.

1.2 TEST CELL CONSTRUCTION PROCEDURES

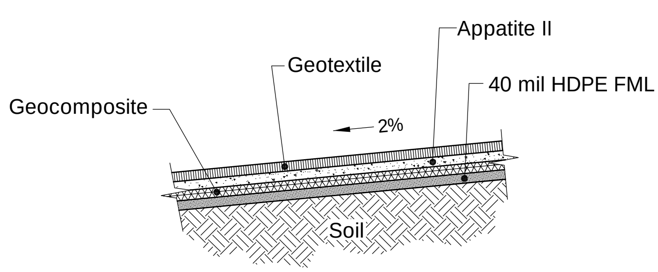
The objective of the test cell construction is to provide a sufficiently impermeable waste enclosure to isolate waste from the environment. Initial site construction activities involve removing previously backfilled clay material from the site construction area. The test cell will then be excavated to specified slopes and depths. The underlying clay will be overlain with a 40-mil high density polyethylene (HDPE) liner, a geonet, and two geotextile membranes with a 4 inch layer of PIMS Apatite II mineral placed between. Included with the test cell is a leachate collection system that will automatically withdraw leachate from a sump to a storage tank. Figure 1 shows the conceptual PIMS treatment unit details.



Plan View



Section "A-A"



Detail 1

Note:
Dimensions are approximate.

Figure 1

PIMS Treatment Unit Details

Camp Stanley Storage Activity

PARSONS ENGINEERING SCIENCE, INC.

739249-01000 CSSA-PIMS.DWG

SECTION 2
RESPONSIBILITY AND AUTHORITY

The principal organizations involved in the construction of a PIMS test cell are CSSA/UFA Ventures, Inc. as the owner, Parsons Engineering Science Inc., as the designer, CQA personnel, and construction contractor(s).

2.1 OWNER

The owner of the test cell is CSSA and UFA Ventures, Inc. and is responsible for construction of the test cell facility. This responsibility includes assuring a reasonable degree of certainty that the test cell is constructed to meet all design criteria, plans, and specifications.

2.2 DESIGN ENGINEER

The primary responsibility of the design engineer, Parsons Engineering Science, Inc., is to design a test cell which fulfills the operational and performance requirements of CSSA and UFA Ventures, Inc.. Additionally, the Design Engineer may be involved in changes to the design or interpretations of design needs with respect to deviations from the specified design or failure of the contractor to meet provisions of the design criteria, plans, and specifications.

2.3 CQA PERSONNEL

The overall responsibility of CQA personnel is to perform those activities specified in the CQA plan. The CQA officer's responsibility include:

1. Reviewing design drawings and specifications for clarity and completeness.
2. Serving as Owner liaison with the Construction Contractor in interpreting and clarifying project drawings and specifications.
3. Educating construction and inspection personnel as to on the job requirements.
4. Scheduling site inspections.
5. Directing and supporting the inspection staff in performing observations and tests.
6. Confirming that test equipment, personnel, and procedures do not change over time, or making sure that any change does not reduce effectiveness of the inspection process.
7. Confirming that test data are accurately recorded and maintained.
8. Verifying that raw data are summarized and interpreted properly.

9. Giving the Owner and Design Engineer reports on inspection results, including:
   - Reviews and interpretations of observation records and test results.
   - Identification of work the CQA officer believes should be accepted, rejected, or uncovered for observation, or that may require special testing, inspection, or approval.
   - Reports that reject defective work and specify corrective measures.
10. For the supporting inspection staff, specific responsibilities include:
    - Verifying the equipment used in testing meets test requirements and that tests are conducted by qualified personnel according to the standard procedures defined by the CQA plan.
    - Monitoring tests as may be required by the contract and/or the design specifications.
    - Performing independent onsite inspection of work in progress to assess compliance with facility design criteria, plans, and specifications.
11. Reporting the results of all observations and tests to the Owner and Design Engineer as the work progresses, and interacting with the Construction Contractor to provide assistance in modifying materials and work to comply with the specified design.
12. Reporting to the Owner and Design Engineer results of all inspections including work not acceptable or failing to meet the specified design.

2.4 CONSTRUCTION CONTRACTOR

It is the responsibility of the Construction Contractor to construct the test cell liner in strict accordance with the design criteria, plans, and specifications.

SECTION 3
PROJECT MEETINGS

Periodic meetings held during the life of the project will clarify responsibility and authority associated with construction of this treatability study test cell.

3.1 PRECONSTRUCTION CQA MEETINGS

A meeting will be held to resolve any uncertainties before commencement of construction. The Owner, CQA personnel, and Construction Contractor will attend. This meeting will acquaint all parties with the CQA plan and their responsibilities with respect to the plan, establish communications channels, review CQA documentation procedures, and review work area security and safety procedures.

3.2 DAILY PROGRESS MEETINGS

A progress meeting will be held daily to review work progress, plan upcoming work activities, assign and coordinate work assignments, and discuss potential construction problems.

The CQA staff will document these meetings.

3.3 PROBLEM OR WORK DEFICIENCY MEETING

As needed, the CQA Officer or Owner may call a special meeting to discuss construction problems or deficiencies. At these meeting, project staff will define and resolve problems or recurring work deficiencies that threaten test cell quality. The meeting will be documented by the CQA Officer.

SECTION 4
PERSONNEL QUALIFICATIONS

The Design Engineer will designate the CQA officer and inspection staff assigned to implement the day-to-day activities and ensure that the test cell meets or exceeds requirements of the design criteria, plans, and specifications.

4.1 CQA OFFICER

The CQA Officer is that individual assigned singular responsibility for implementing all aspects of the CQA plan. The CQA Officer is responsible to the design engineer and owner.

Qualifications of the CQA Officer assigned to the project include adequate formal academic training in engineering, earthwork construction, or closely-associated disciplines, and sufficient practical, technical, and managerial experience to successfully oversee and implement CQA activities for the PIMS treatability study. The CQA Officer will ensure that communication of all CQA-related matters is conveyed to and acted upon by the affected organizations.

4.2 CQA STAFF

The CQA staff personnel designated to implement the CQA plan will possess adequate formal training and sufficient practical, technical, and administrative experience to execute and record inspection activities successfully. This includes demonstration knowledge of specific field practices and construction techniques concerning material and equipment installation, observation and testing procedures, documentation procedures, and site safety.

4.3 CONSULTANTS

Authorities in engineering, engineering geology, geotechnical engineering, soil mechanics, geomembranes, chemistry, and other technical disciplines may be called in from external organizations to address any unusual site conditions or test results. The CQA staff will prepare detailed documentation whenever such expert technical judgments are used for a decision in some aspect of construction or design. Consultants will not be employed to substitute objective data collection and interpretation when suitable tests are available.

SECTION 5
INSPECTION ACTIVITIES

This section describes the inspection activities by CQA personnel during the treatability test cell liner construction. These activities are necessary to ensure, with a reasonable degree of certainty, that the completed facility meets or exceeds the design criteria, plans, and specifications. Subsequent subsections address each facility component separately and are further subdivided into sections on preconstruction, construction, and post construction activities unique to each component.

5.1 GENERAL PRECONSTRUCTION ACTIVITIES

This activity will consist of a preconstruction meeting in which the individual responsibilities of the Construction Contractor, CQA personnel, and Owner are outlined and reviewed. CQA inspection personnel will review all inspection procedures at this time and, if necessary, will undergo training to familiarize all inspectors with procedures outlined in this document. In addition, samples of the geomembrane liner may be tested as shown in Table 1.

5.2 GEOMEMBRANE LINER

The bottom geomembrane liner, which overlies the clay liner, is a 40-mil high-density polyethylene flexible geomembrane. The geomembrane liner prevents infiltration of liquids through the liner system. All seams for the geomembrane liners will be field fabricated.

5.2.1 Preconstruction

The geomembrane liner will arrive at the job site in rolls. Each roll will be labeled by the manufacturer indicating:

1. Name of manufacturer/fabricator
2. Product type
3. Manufacture batch code
4. Date of manufacture
5. Physical dimensions (length, diameter, and thickness)
6. Purchase order number

Table-1
Methods For Testing Geomembrane Liner

MATERIAL	PROPERTY	METHOD
Geomembrane Liner	Density	ASTM D792 Method B or ASTM D1505 Method A
	Tensile Strength @ Yield	ASTM D638 Speed C Type IV (2"/min.)
	Tensile Strength @ Break	ASTM D638 Speed C Type IV (2"/min.)
	Elongation @ Yield	ASTM D638 Speed C Type IV (2"/min.)
	Elongation @ Break	ASTM D638 Speed C
	Thickness	ASTM D1593 and ASTM D374
	Tear Resistance	ASTM D1004 Die C
	Carbon Black N550 Content	ASTM D1603
	Bonded Seam Strength	ASTM D638 Speed C Type IV (2"/min.)
	Peel Test	ASTM D413
	Dimensional Stability	ASTM D1204
	Melt Flow Index	ASTM D1238 Condition E
	Puncture Resistance	FTMS 101 Method 2065

The CQA staff will assess the manufacture's test results to ensure that the geomembrane liner components meet the quality standards of this CQA plan. Tests may be performed according to the methods shown in Table 1. The CQA officer may require additional destructive tests at his discretion. All destructive and non-destructive test results will be recorded by CQA personnel and retained for documentation..

In addition, CQA inspectors will:

1. Inspect and verify that all geomembrane liner shipments are for use on the project and have not been damaged in transit. The CQA staff will document the acceptance of incoming geomembrane liners in the CQA files. No geomembrane liner may be used until inspected by the CQA staff.
2. Inspect and verify that the area proposed for the geomembrane liner storage offers adequate protection against mechanical damage, excess weather exposure, high winds, and vandalism. No storage will be allowed until the CQA inspector approves and documents this area.
3. Inspect and verify that handling of the rolls is in accordance with the specifications and manufacture's recommendations.

5.2.2 Construction

CQA inspectors will:

1. Note and record the weather conditions (*i.e.* temperature, humidity, precipitation, and wind) as panels are placed. The CQA staff will refer to the construction specifications and confirm that weather conditions are suitable.
2. Measure and verify that overlap of adjacent membrane sheets is at least 4 inches. Each seam overlap will be spot checked at three or more locations along the seam. Any seam having an overlap of less than 4 inches will be relocated prior to bonding.
3. Observe that each panel contains no tears, punctures, or obviously thin spots during placement and mark any defects on the membrane with colored grease pen or paint for repair.

5.2.3 Welder Certification and Testing

Each welder will qualify his or her welding equipment at the beginning of each workday by running a sample weld and peel, testing at least three 1-inch test specimens from the weld. All specimens must pass before production welding will be allowed.

5.2.4 Seaming

Operations must be conducted according to the drawings, specifications, and manufacture's recommendations. For HDPE membrane, all seams must be welded. CQA personnel will maintain continuous observation of all geomembrane liner seaming operations to assure that the work is performed according to accepted procedures. All welders must be qualified by experience or successfully passing seaming tests. Specific activities to be performed by CQA personnel during geomembrane liner seaming are as follows:

1. Observe that all overlapped areas to be seamed are free from dirt, dust, and moisture, and that the bearing beneath the geomembrane liner seam is firm and compact.
2. Verify that the seam overlaps are ground properly prior to extrusion welding.
3. Record weather conditions prior to seaming operations and assure that ambient conditions are appropriate. No weld will be done below 34°F. Between 34°F and 50°F, seaming is possible if the membrane is preheated by the sun or a hot air device and if there is no excessive cooling from wind. Above 50°F, preheating is not required. In all cases, the geomembrane liner must be dry.
4. Verify that seaming materials and equipment meet or exceed appropriate standards. Each extrusion seaming unit will include a thermometer giving the extrusion temperature at the nozzle.
5. Verify that fishmouths or wrinkles at the seam overlaps are cut along the ridge of the wrinkle back into the panel for a flat overlap. Verify that wrinkles are seamed and patched with a round or oval patch of HDPE material extending a minimum of 6 inches beyond the cut in all directions.
6. Prevent excessive equipment or pedestrian traffic on the seams or geomembrane liner.

5.2.5 Postconstruction

1. Verify that all field seams are nondestructively tested by the Construction Contractor using a pressure test of an open-bottom vacuum box. One hundred percent of the field seams must pass all tests performed. Seams successfully tested will be marked by the CQA staff with a distinctive marker or spray paint.
2. Verify that all geomembrane liner repairs and seam tests or repaired sections are acceptable.
3. All seals which cannot be vacuum tested will be observed, approved and documented by the CQA staff.
4. Conduct a final visual inspection of the panel and perimeter seams and repairs following testing of all seams around a panel. Acceptable panels will be identified with a distinctive paint marking. After this final marking, no contractor personnel will be allowed on the panel except to place successive liner components.

5.3 LEACHATE COLLECTION SYSTEM

The leachate collection system (LCS) consists of a geonet placed on top of the HDPE liner and geotextile layers which contain a 4 inch layer of Apatite II mineral between the geotextile layers. The bottom of the test cell will be sloped to allow leachate to drain into a collection sump. Liquids collected in the sump will be pumped out.

5.3.1 Preconstruction

CQA personnel will inspect all materials for the LCS construction. Specific activities are as follows:

1. Visually inspect geotextile and geonet for any holes, tears, or physical damage which would cause it to fail in service.
2. Inspect sump to assure design conformance.
3. Construction

Geonet placement: The geonet will act as the drainage layer and will be placed between the liner and the geotextile layers. CQA personnel will:

1. Collect samples and determine conformance to construction specifications.
2. Observe placement to ensure conformance to manufacturers recommendations and specifications, including coverage of all specified areas and adequate material overlap if adjacent sheets are not sewn or otherwise joined in an approve fashion.
3. Observe placement to ensure that the geonet or any other system subcomponent is not damaged.

Geotextile placement: The geotextile layers will be placed above the geonet and act as a filter for the LCS. An approximate 4-inch layer of Apatite II mineral will be placed between the two geotextile fabric layers. CQA personnel will analyze manufacturer's test results to ensure that the geotextile fabric meets the quality standards of this CQA plan. During geotextile placement, CQA personnel will:

1. Collect samples and determine conformance to construction specifications.
2. Observe placement to ensure conformance to manufacturer's recommendations and specifications, including coverage of all specific areas and adequate material overlap if adjacent sheets are not sewn, or otherwise joined in an approved fashion.
3. Observe placement to ensure that the geotextile or any other system subcomponent is not damaged.

5.3.2 Postconstruction

CQA personnel will inspect all installed LCS subcomponents to ensure installation in the specified locations and absence of any obvious physical damage.

5.4 SAMPLING

The frequency of sampling has been established for each material or process to allow comparison with the outlined requirements. The method and acceptance criteria of sampling and testing for preconstruction and construction activities are listed in Tables 1 and 2.

The location of each sample measurement within a block will be chosen by a random method, *i.e.,* one in which a possible sample location has a known and equivalent probability of being chosen. There are two different units of measure for blocks (square foot and linear foot), and each of these units has a different method of randomly selecting measurement points.

Blocks of material or work measured in square feet will be divided into at least 10 subsections of equal surface area when the material is readied for sampling. This division may be made by the CQA officer using drawings of the completed installation or other convenient means. Each subsection thus created will be assigned a unique number. For instance, if there are 10 subsections within a particular block, the subsections will be numbered from 1 to 10.

The assigning of numbers to subsections within a block measured in square feet does not have to follow any particular pattern. After numbers are assigned to subsections, a random number will be chosen to determine subsection(s) to be sampled. The resulting samples may be collected from anywhere within the chosen subsections. Only CQA personnel will know the identity of the subsection(s) to be sampled.

Blocks of material or work measured in linear feet will be divided into at least 10 subsections of equal length. Procedures for dividing the blocks, assigning numbers to subsections, and choosing sample locations will be identical to those used for blocks measured in square feet.

5.5 ACCEPTANCE CRITERIA

Criteria for acceptance of materials or work sampled are provided in Table 2.

5.6 TREATMENT OF AN OUTLIER

Occasionally, in homogeneous samples, one of the test values may deviate markedly from the remainder. This is called an outlier. The identification and management of outlier data are important because outliers do not necessarily signify unacceptable construction methods or materials, even though they may lie outside established acceptance criteria.

The CQA officer will identify and manage outlier values. If the CQA officer determines the outlier as simply a manifestation of extreme variance, the outlier will be processed with the remainder of the data. If the CQA officer determines that the outlier may be due to sampling, testing, or other error, which prejudices the ability of the results

Table-2
Acceptance Criteria for Geomembrane Liner

ITEM TO BE SAMPLED	ACCEPTANCE CRITERIA
Geomembrane Liner	
Density (g/cm^3)	0.940 g/cm^3 (min) sheet for Method B 0.935 g/cm^3(min) resin for Method A
Tensile Strength @ Yield (psi)	2050 psi (min)
Tensile Strength @ Break (psi)	3200 psi (min)
Elongation @ Yield	8% (min)
Elongation @ Break	500 % (min)
Thickness	Nominal ±10% mil
Tear Resistance	45 lbs
Carbon Black N550 Content	2.0-3.0 %
Bonded Seam Strength	2,000 psi (min) @ Yield
Peel Test	1,500 psi (min)
Dimensional Stability	±3 percent
Melt Flow Index	0.1 - 0.4 g/10 min
Puncture Resistance	70 lbs

to define construction quality, the block will be resampled. In cases when resampling is not possible or practical, the CQA officer may authorize dropping the outlier data from the evaluation. The handling of outliers by resampling or failure to include the outlier data will be documented in the CQA records of the project.

5.7 CORRECTIVE MEASURES

The CQA records of the project will contain the results of tests to document that the various components were constructed in a manner consistent with the design criteria, plans, and specifications. In cases where test results do not conform to the acceptance criteria, corrective measures will be taken.

For materials subject to 100-percent inspection, substandard material will simply be replaced and retested. For materials or workmanship subject to judgmental or statistical methods, test results outside of criteria will be evaluated as outliers and managed as previously discussed. Materials which the CQA officer determines to have failed testing or retesting will be replaced or reworked and then resampled as directed by the CQA officer.

In some instances, the Design Engineer and CQA officer may determine that test results reflect satisfactory construction quality, even though the acceptance criteria are not explicitly met. In these cases, the agreement that the sampled work is satisfactory will be recorded on a "Problem Identification and Corrective Measures Report" (see Figure 4). This report also will be signed by the design engineer.

5.8 DOCUMENTATION

Recordkeeping on any construction project serves a number of important purposes: payment of contractor services, arbitration of disputes among the Owner, Construction Contractor, and others. In the case of this CQA plan, records are required to assure the treatability test cell has been constructed in conformance with the plans and specifications. Additionally, well-organized and complete records will allow the various test cell components to be located should any trouble occur after the facility is in use.

5.9 DAILY RECORDKEEPING

Required daily recordkeeping is the responsibility of the CQA officer. Preparation of a daily summary report (Figure 2) with supporting data sheets and, when appropriate, problem identification and corrective measures report(s) will be completed by the CQA officer.

Figure 2
Daily Summary Report

<table>
<tr>
<td>DAILY MEETING SUMMARY
Names of persons present:

Purpose of meeting:

Topics discussed:

Supporting documents</td>
<td>SUMMARY OF CONSTRUCTION PROGRESS
Location
1.
2.
3.
Unit Process
1.
2.
3.
Equipment and personnel working in
Each Unit Process:
1.
2.
3.</td>
<td rowspan="3">FIGURE CQAP-2
DAILY SUMMARY
REPORT

UFA Ventures, Inc.

CONSTRUCTION OF
PIMS Test Cell

SHEET No.:

DSR- ___________________

DATE: __________________

____
CQA FIELD OFFICER</td>
</tr>
<tr>
<td>MATERIAL INSPECTION SUMMARY

Material Received/Vendor:
1.
2.
3.
4.</td>
<td>BLOCK INSPECTION SUMMARY
Areas inspected
1.
2.
3.
Results of inspections (reference insp. docs.):
Results
1.
2.
3.
Corrective Actions Initiated:
1.
2.
3.</td>
</tr>
<tr>
<td colspan="2">WEATHER DATA:

High Temperature   Precipitation:
Low Temperature: Comments:</td>
</tr>
</table>

5.9.1 Inspection Data Sheets

Observations and field and/or laboratory tests may be recorded on an inspection data sheet. The inspection data sheet is shown in Figure 3. Any field notes or sketches made by inspectors or vendor tests results sheets will be copied and attached to the inspection data sheets, including appropriate document numbers assigned to the attachments. The inspection data sheet must be signed by the inspector and the CQA officer.

5.9.2 Problem Identification and Corrective Measures

The problem identification and corrective measures report is shown as Figure 4. This report identifies material or workmanship not meeting the design criteria, plans, or specifications. Each time a block of work or other item does not meet these requirements, a problem and corrective measures report will be completed and signed by the CQA officer.

5.9.3 Photographic Reporting Data Sheets

The photographic reporting data sheets may be found as Figure 5. Each time a photograph is taken as part of the inspection or other CQA activities, the photo will be logged on the photographic reporting data sheet and signed by the photographer. The CQA officer will sign the completed photograph record sheet(s).

5.10 ACCEPTANCE OF COMPLETED COMPONENTS

Additionally, the Owner may use other forms to record inspections and acceptance of components during construction.

5.11 FINAL DOCUMENTATION

Upon completion of construction of the test cells, the Owner will have on file at the facility a final certification report. This report will include copies of all the completed forms, photographs, and as-built drawings. The CQA officer will prepare this document and certify that it is correct and complete.

Figure 3
Inspection Data Sheet

DATE: SHEET.: IDS-

INSPECTION ACTIVITY (e.g., liner seaming, fill depth, etc.)

ACTIVITY LOCATION (plant or cell grid coordinates):

SAMPLE COLLECTION LOCATION(S) (if applicable):

INSPECTION PROCEDURE (e.g., visual obs., ASTM #, etc.):

OBSERVATION DATA (e.g., test results, notes, etc.):

COMPARISON WITH SPECIFICATIONS (test results vs. specs)

INSPECTOR **CQA FIELD OFFICER**

Figure 4
Problem Identification and Corrective Measures Report
Construction of PIMS Test Cell

SHEET No.: PCM-

LOCATION

DESCRIPTION OF IDENTIFIED PROBLEM:

PROBABLE CAUSE:

HOW AND WHEN WAS PROBLEM LOCATED AND HOW LONG HAS PROBLEM EXISTED?:

SUGGESTED CORRECTIVE MEASURES:

FINAL RESULTS:

SUGGESTED METHOD(S) TO PREVENT SIMILAR

PROBLEMS:

____
CQA FIELD OFFICER DATE

CORRECTIVE MEASURES INSPECTION RESULTS FOUND ON REPORT:

IDS

Figure 5
Photographic Reporting Data Sheets

Construction Of PIMS Test Cell
SHEET NO.: PRS-

PHOTOGRAPH NUMBER	DATE	TIME	LOCATION	DIRECTION	WORK PHOTOGRAPHED	PURPOSE OF PHOTOGRAPH	PHOTOGRAPHER SIGNATURE

CQA FIELD OFFICER DATE

Appendix F
Health and Safety Plan

PREFACE

The purpose of this Health and Safety Plan (HSP) is to establish personnel protection standards and mandatory safety practices and procedures for all work conducted in association with the closure activities for solid waste management units at Camp Stanley Storage Activity (CSSA), Boerne, Texas.

This document was prepared by Parsons Engineering Science, Inc. (Parsons ES) of Austin, Texas for CSSA under the U.S. Air Force Air Mobility Command (AMC) Contract F11623-94-D0024, delivery order RL17.

The provisions of this plan are mandatory for Parsons ES personnel during on-site investigations, and personnel shall abide by this plan. All Parsons ES personnel who engage in field investigation activities shall be familiar with this plan and comply with its requirements. Any supplemental plans used by subcontractors shall conform to this plan as a minimum. The development, implementation, and enforcement of the HSP is the responsibility of Parsons ES.

The Parsons ES Project Manager, Ms. Susan V. Roberts, is responsible for preparation of the HSP. Randy M. Palachek, the Office Health and Safety Manager, reviews the HSP and provides information regarding site safety issues. Technical oversight is performed by Jo Jean Mullen, Air Force Center for Environmental Excellence/Environmental Restoration Division (AFCEE/ERD).

All brand and product names used herein are trademarks or registered trademarks of their respective companies.

This HSP is intended to cover field work performed under this delivery order from 1 November, 1999 to 30 September 2000. Ms. Nancy Stine, AMC CONF/LGCFB is the contracting officer.

PURPOSE OF DOCUMENT

The purpose of this HSP is to establish personnel protection standards and mandatory safety practices and procedures for Parsons ES personnel employed in the closure activities of solid waste management units (SWMUs) at CSSA, Texas. The plan also provides responses for contingencies that may arise during field investigations. The provisions of this plan are mandatory for all on-site activities. All Parsons ES personnel on the site will abide by this plan unless otherwise specified through formal addenda. Subcontractors will be required to submit their own HSP which conforms to the requirements of this plan, at a minimum.

The expertise of personnel from various disciplines will be employed to assist in conducting field investigation safely. This plan complies with requirements of the Occupational Safety and Health Administration (OSHA) Title 29, Code of Federal Regulations Parts 1910 and 1926 (29 CFR 1910 and 1926) and other applicable health and safety regulations.

NOTICE

This report has been prepared for the United States Army and AFCEE by Parsons Engineering Science, Inc. for the purpose of the Air Force Installation Restoration Program (AFIRP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force Final decision on remedial action may be in the public's interest. The limited objectives of this report and the ongoing nature of the AFIRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report since subsequent facts may become known that make this report premature or inaccurate.

Copies of this report may be purchased from:

1. Government agencies and their contractors registered with the Defense Technical Information Center should direct requests for copies of this report to: Defense Technical Information Center, Cameron Station, Alexandria, VA 22304-6145.

2. Nongovernment agencies may purchase copies of this document from: National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

EMERGENCY CONTACTS

EMERGENCY CONTACTS

In the event of any situation or unplanned occurrence requiring assistance, the appropriate contact(s) will be made from the list below. For emergency situations, contact will first be made with the Field Team Leader (or designee), who will notify CSSA emergency personnel. This emergency contacts list must be kept at hand by field members.

Emergency Contacts

Contact	Phone Number
Emergency dispatcher	911
Camp Bullis fire department	210/221-7517
Post police, building 79	210/221-7408
Paul Oliver, Camp Stanley safety officer, building 1	210/221-7473
Brian Murphy, Camp Stanley environmental officer	210/698-5208
Poison Control Center	800/492-2414
National Response Center	800/424-8802

Note: When on CSSA, dial "1" and the last four numbers (except for 911).
For toll-free and local calls dial "9".

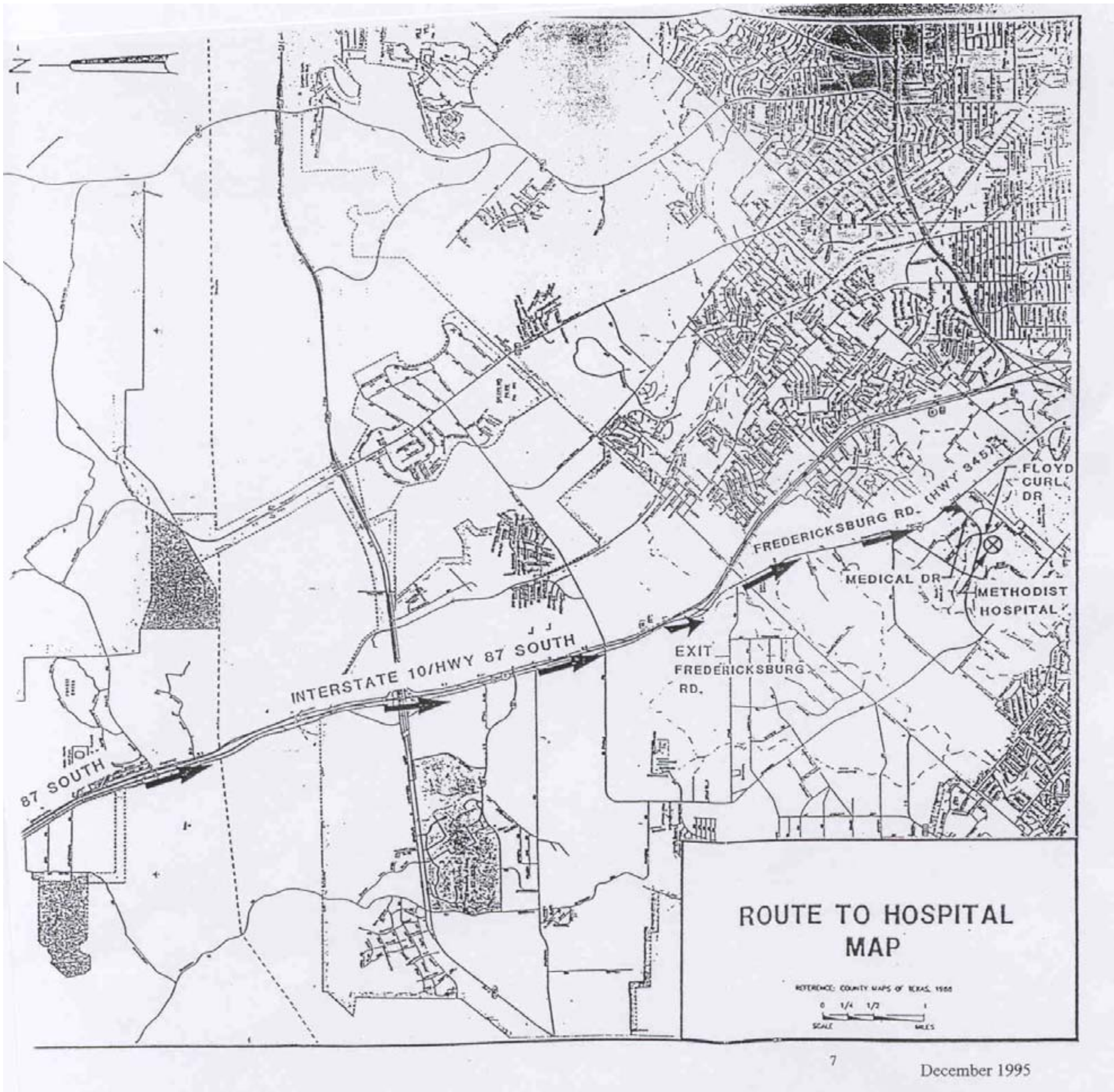
Medical Emergency

Hospital	Methodist Hospital
Phone number	210/692-4444
CSSA Ambulance service (0730-1600 hrs.)	210/221-7408
Address	7700 Floyd Curl San Antonio, Texas
Travel time from site	15 minutes

Map to hospital is on next page.

Route to hospital: See map on next page identifying hospital location. Hospital is located on corner of Medical and Floyd Curl Drive. The route from the CSSA main gate is south on Ralph Fair Road about 0.75 mile, south on Interstate 10 about 12.5 miles, west on Medical Drive about 0.5 mile, and south on Floyd Curl Drive to hospital.

HOSPITAL MAP



PARSONS ENGINEERING-SCIENCE CONTACTS

Contact	Phone Number
Parsons ES Project Managers:	
Susan Roberts, Austin, Texas	512/719-6051
Julie Burdey, Austin, Texas	512/719-6062
Ken Rice, Austin, Texas	512/719-6050
Scott Pearson, Austin, Texas	512/719-6087
Parsons ES Task Manager:	
Shavonne Gordon, Austin, Texas	512/719-6011
Parsons ES Site Health and Safety Officer:	
Kyle Caskey, Austin, Texas	210/805-6222
Parsons ES Technical Directors:	
David Highland, Austin, Texas	512/719-6060
John Yu	512/719-6057
Parsons ES Office Health and Safety Representative:	
Randy M. Palachek, Austin, Texas	512/719-6005
Parsons ES Corporate Health and Safety Manager:	
Ed Grunwald, Atlanta, Georgia	404/325-0770

Air Monitoring Action Levels

Action Level (Concentration of Organic Vapor in Breathing Zone)	Method of Detection	Action
	Oxidation Pond	
< 25 ppm Total VOC	PID or FID	Downgrade to Level D protection
≥ 250 ppm Total VOC	PID or FID	Stop work. Leave the site until conditions subside.
>10% LEL	Combustible Gas Analyzer	Stop work. Leave the site until conditions subside.
> 10 mg/m^3 limestone particulates	MINIRAM™	Leave area or upgrade to respiratory particulate protection.
	All SWMUs except the Oxidation Pond	
25-50 ppm Total VOC < 25 ppm Tetrachloroethylene	PID or FID Colormetric Tubes	Level D PPE

25-50 ppm Total VOC ≥ 25 ppm Tetrachloroethylene	PID or FID Colormetric Tubes	Leave area or upgrade to Level C personal protective equipment.
50-250 ppm Total VOC	PID or FID	Leave area or upgrade to Level C personal protective equipment.
≥ 250 ppm Total VOC	PID or FID	Stop work. Leave the site until conditions subside.
>10% LEL	Combustible Gas Analyzer	Stop work. Leave the site until conditions subside.
> 10 mg/m^3 limestone particulates	MINIRAM™	Leave area or upgrade to respiratory particulate protection.

Notes:

VOC - Volatile Organic Concentration
PID - Photoionization Detector
FID - Flame Ionization Detector

Oxidation Pond

Drilling actions in the oxidation pond will be started in level C PPE because of suspected VOC contamination. If in the event air monitoring indicates Level C as not necessary, the Site Health and Safety Officer, in conjunction with Parsons ES Austin designated health and safety officer, may allow Level D PPE.

All SWMUs except for the Oxidation Pond

Respiratory protection will not be required if the concentration of Total VOCs is below 25 ppm. If the concentration of Total VOCs is above 25 ppm, colormetric tubes will be used to measure the concentrations of the constituents of concern. Total VOCs is measured with a PID or FID. If the concentration of Total VOCs exceeds 250 ppm, all personnel shall stop work and leave the area. See Table 3.1 for the action levels for implementing C and D levels of protection. Contaminant concentrations can be controlled using engineering controls (ventilation, wetting, etc.) to allow the use of a lower level of protection, provided that monitoring shows that the concentrations have been reduced to the appropriate ranges.

During drilling actions via air coring, a substantial amount of particulate matter will be generated and airborne. A particulate MINIRAM™ monitor and an organic vapor monitor will be used to differentiate between level C and level D protection. If the particulate level exceeds 10 mg/m^3 (the TLV for limestone dust) dust masks or some other form of respiratory protection with dust protection cartridges will be worn.

TABLE OF CONTENTS

Page

APPENDICES

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
AFCEE/ERD	Air Force Center for Environmental Excellence/Environmental Restoration Department
AFIRP	Air Force Installation Restoration Program
AMC	Air Mobility Command
CFR	Code of Federal Regulations
CMS	Corrective Measures Study
CNS	Central nervous system
COR	Contracting officer's representative
CPR	Cardiopulmonary resuscitation
CRZ	Contamination reduction zone
CSSA	Camp Stanley Storage Activity
dB	Decibel
DD	Demolition dud
EM	Electromagnetometer
EZ	Exclusion zone
FID	Flame ionization detector
GPR	Ground penetrating radar
HSP	Health and Safety Plan
IDLH	Immediately dangerous to life or health
LEL	Lower explosive limit
MSDS	Material safety data sheet
NIOSH	National Institute of Occupational Safety and Health
OEW	Ordnance and explosive waste
OSHA	Occupational Safety and Health Administration
Parsons ES	Parsons Engineering Science
PCB	Polycyclic biphenols
PEL	Permissible exposure limit
PID	Photoionization detector
POC	Point of contact
PPE	Personal protective equipment
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RRAD	Red River Army Depot
SHSO	Site Health and Safety Officer
SOW	Statement of work

SVOC	Semivolatile organic compound
SWMU	Solid waste management unit
SZ	Support zone
TLV	Threshold limit value
UXO	Unexploded ordnance
VOC	Volatile organic compound

SECTION 1

INTRODUCTION

1.1 PURPOSE AND POLICY

The purpose of this safety plan is to establish personnel protection standards and mandatory safety practices and procedures for all work conducted in association with the closure activities of low, medium, and high priority SWMUs at the U.S. Army installation, CSSA, located about 10 miles south of Boerne, Texas. The plan assigns responsibilities, establishes standard operating procedures, and provides for contingencies that may arise during performance of work tasks at the project site. This plan complies with requirements of OSHA 29 CFR 1910 and 1926, and other applicable health and safety regulations.

The provisions of the plan are mandatory for all on-site Parsons ES field personnel and site visitors (i.e. CSSA and AFCEE representatives). All Parsons ES personnel will abide by this plan as indicated by their signatures on the plan acceptance form (Appendix A). All Parsons ES personnel who engage in project activities must be familiar with this plan and comply with its requirements. Accidents specifically related to this project will be reported using the form in Appendix A. In addition, the U.S. Department of Labor OSHA, "Job Safety and Health Notice" is presented in Appendix A and must be present on site.

The expertise of personnel from various disciplines will be employed to assist in safely conducting the field investigation. A drilling crew will provide drilling services. Parsons ES personnel will collect samples and provide oversight of field activities. Subcontractors will be required to submit their own health and safety plans which must conform to the requirements of this plan at a minimum.

Although the primary mission of CSSA is to receive, store and issue military supplies, the risk is low that field team members will encounter any unexploded ordnance (UXO) during the duration of the field effort. UXO is an item of ordnance and explosive waste (OEW) which has been prepared for action, and which has been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard and remains unexploded for any reason. OEW includes anything related to munitions designed to cause damage to personnel or material through explosive force. Although UXO may be encountered at any SWMU, the following SWMUs may include UXO due to historic use: Building 43, B-1, B-2, B-5, B-7, B-8, B-10, B-11, B-15, B-16, B-19, B-24, B-28, and DD.

The majority of the SWMUs planned for closure activities are listed as low and medium priority SWMUs. In particular, an Environmental Assessment at CSSA used old records and field observations to note small ammunition (ES, 1993). These notes will be verified before any invasive work takes place. **However, if any UXO material is encountered at any of the SWMUs designated for work actions, work at that**

SWMU will stop immediately. The perimeter surrounding the area will be secured and only qualified personnel will be allowed to enter. The Site Health and Safety Officer, Field Team Leader, Project Manager and installation point of contact (POC) will be notified and the Health and Safety plan will be amended as necessary.

The Contracting Officer's Representative (COR) and CSSA environmental officer shall be immediately notified, via telephone, of any investigation results that may indicate potential imminent health risk to contracted or federal personnel, or the public at large, followed within 3 days by written notification and supporting documentation.

All field team members are responsible for reading and complying with this health and safety plan. No employee shall perform a project activity that he or she believes may endanger his or her health and safety or the health and safety of others.

1.2 SITE HISTORY AND DESCRIPTION

CSSA is a subinstallation of the US Army Red River Depot (RRAD), located in Texarkana, Texas. The primary mission of CSSA is receipt, storage, and issuance of supplies, as well as quality assurance testing and maintenance of military weapons and ammunition (US Army, 1971). Figure 1.1 shows the location of CSSA. Figure 1.2 shows the location of the SWMU sites within CSSA.

Project data collection will be through review of available environmental and other relevant CSSA documents, and field data collection actions such as drilling and sampling. However, the appropriate level of data collection per each SWMU will be based on known data about each site. Preliminary evaluation of SWMUs at CSSA has categorized the SWMUs as of low, medium, or high priority based on risk to human health and the environment. The historic use and description of each SWMU is listed in Tables 1.1, 1.2, and 1.3.

Low priority CSSA SWMUs are identified as B-1, B-5, B-6, B-7, B-8, B-12, B-14, B-19, B-22, and coal bins. Expected closure information requirements should be minimal for B-1, B-8, B-14, B-19, and the coal bins; therefore, expected work include letter reports delisting these SWMUs, with no field activities. For the remaining low priority SWMUs, minimal field investigation activities, including sampling and analysis, are expected. Table 1.1 lists the low priority SWMUs.

Medium priority SWMUs are identified as B-9, B-13, B-25, B-26, B-27, B-29, B-30, B-31, B-32, B-33, and B-34. B-25 is assumed to be included as it is listed on *the CSSA Environmental Assessment*, September 1993 list of SWMUs, though it was not listed in Table A-1 of the SOW. The medium priority SWMUs are expected to require conventional and reasonable field activities to gather appropriate closure data. Site activities are expected to include topographical and geographical surveys, drilling, and surface and subsurface sampling. Table 1.2 lists the medium priority SWMUs.

High priority SWMUs for CSSA include the oxidation pond and B-2, B-3, B-4, B-10, B-11, B-15/16, B-23 and 23A, B-24, B-28, the demolition dud (DD) area, building 43 and incinerator I-1. In accordance with paragraph 4.01, the cost estimate for high priority

SWMUs includes a treatability study of the oxidation pond. The costs also include mapping, geophysical surveys, and soil gas surveys, at the building 43, incinerator-1, and B-10, and soil surveys at B-11, B-15/16, and B-23/23A. However, if the delivery order schedule and funds permit, then closure activities for the remaining high priority SWMUs will be conducted. Table 1.3 lists the high priority SWMUs.

1.3 SCOPE OF WORK

For project numbers C1195 and C1295, Parsons ES' understanding of the project requirements is based on the AMC's Statement of Work (SOW) and our past working experience at CSSA.

The SOW specifies the primary services as closure investigations for identified SWMUs (task 1), and preparation of an integrated waste management and spill plan (task 2). Secondary services shall include actions necessary to obtain data to establish closure procedures for task 1.

SWMU closure actions are discussed in the SOW in accordance with Resource Conservation and Recovery Act (RCRA) Facility Investigations (RFIs) and Corrective Measures Studies (CMSs). The effort for task 1 is structured under an RFI approach that is defined under federal regulations; however, the goal of this task is to investigate SWMUs for certified closure under the guidance of appropriate State of Texas regulations as well as federal regulations. The State of Texas has an approved program for SWMU closures under 30 Texas Code of Administration 335, and therefore the SWMU closure task is considered to be work towards certified SWMU closures rather than a structured RFI. Project work under the SWMU closure task will assess the closure potential of each SWMU identified in the SOW and provide the necessary information to accomplish certified closures for approval by the State of Texas in a cost-effective manner.

Figure 1.1 Camp Stanley Storage Activity Location Map

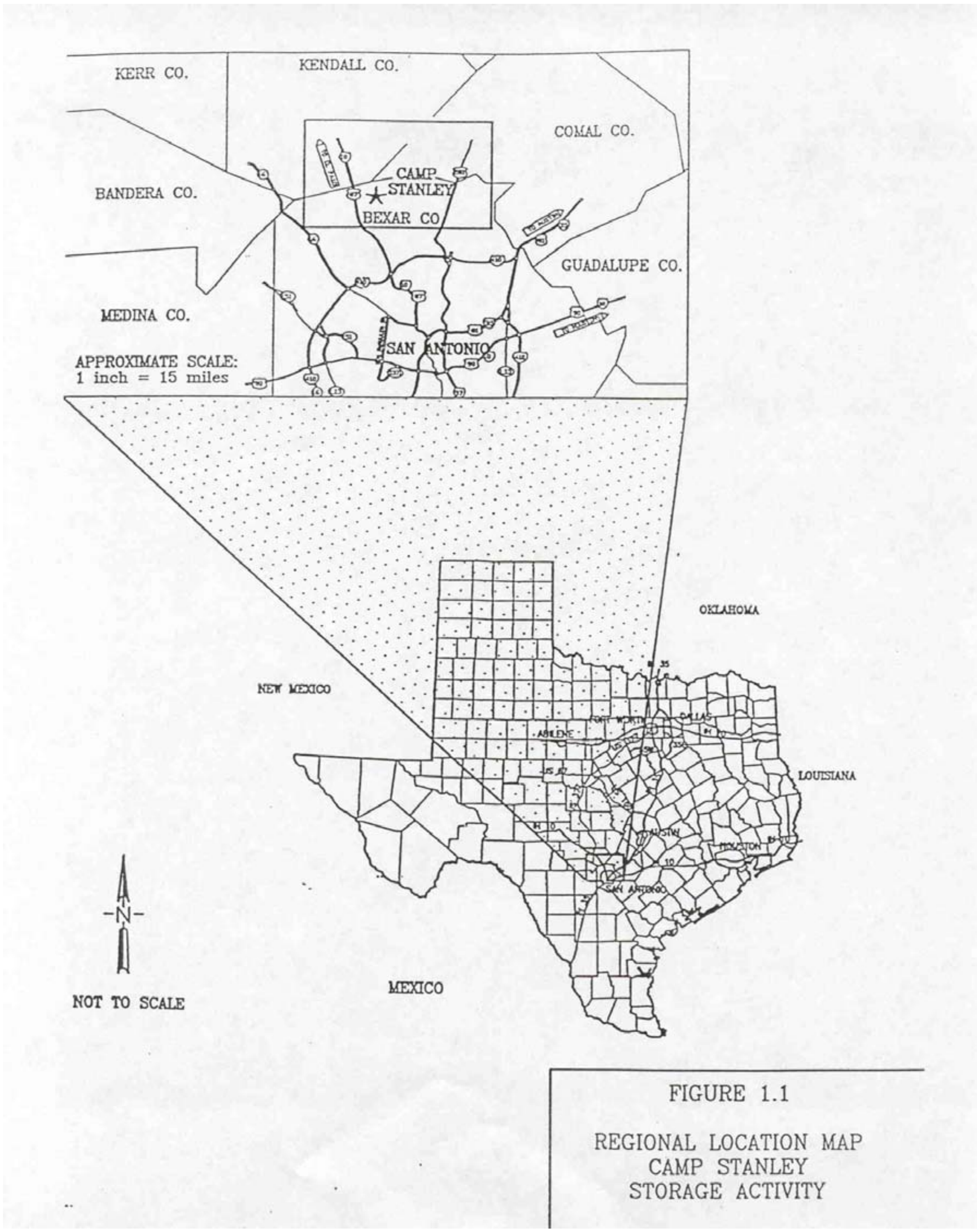


Figure 1.2 SWMUs Location Map

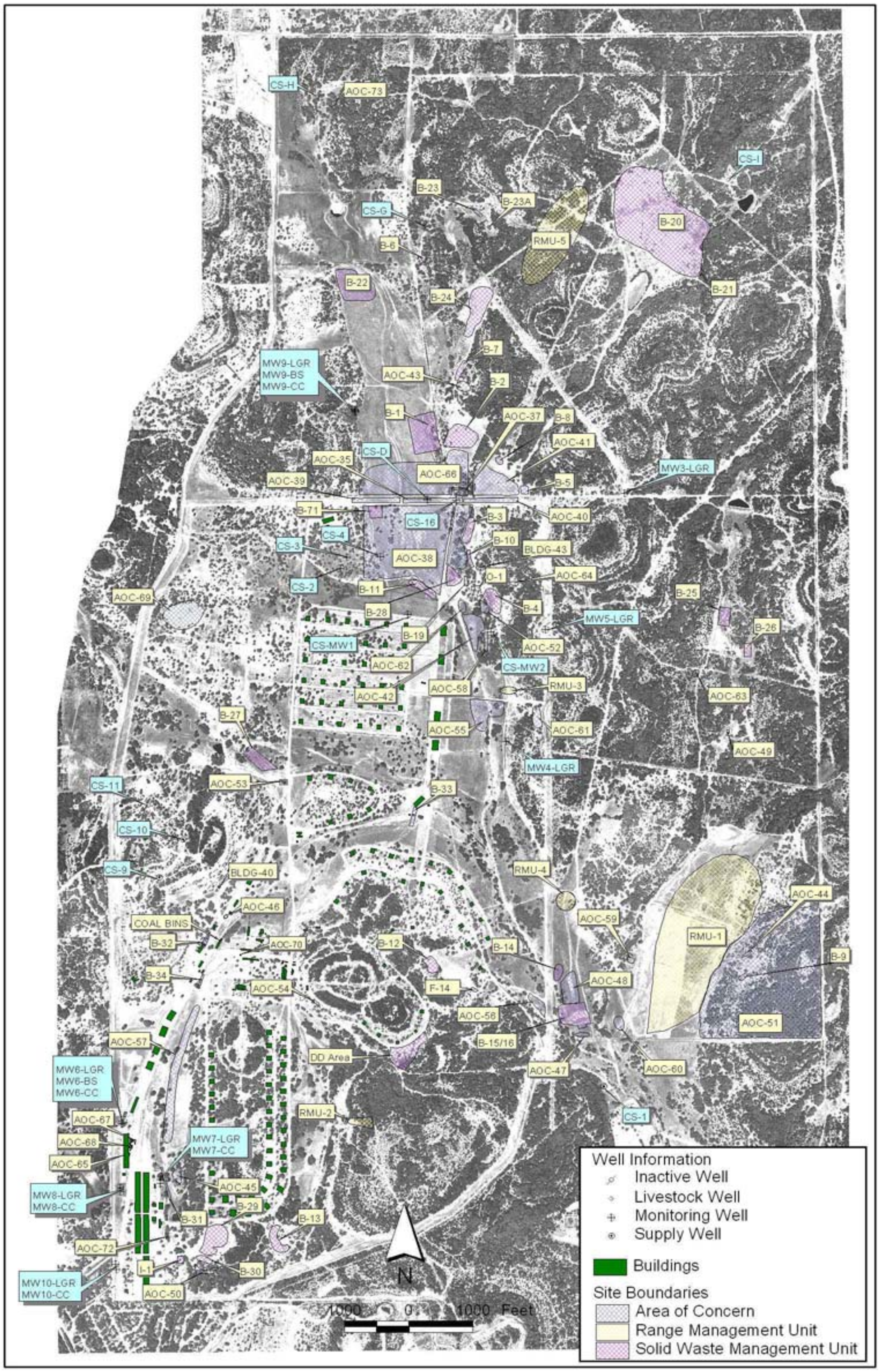


Table 1.1 Low Priority Solid Waste Management Units at CSSA

Unit No.	*Status (Priority)*	*Main Use*	*Historic Use (notes from Environmental Assessment, September 1993)*	*Summary of Preliminary Field and Geophysical Results*	*Approximate Location*
B-8	Low	B/Ds	Fired small arms ammunition brass area consisting of piles of fire bricks and ammunitions shells and remains.	No evidence of subsurface disturbance	North pasture
B-14	Low	B/Ds (if exists)	An area believed to be a fired brass area. This area could not be located during the field survey even with the area upturned from fence repair operations.	Have not investigated yet	Reported to be in the east pasture.
B-1	Low	B/Ds	Powder and ammunition burn area used in 1954 for burning powder and incendiary materials (CSSA, 1991). This information was field verified through areas of stressed vegetation.	No anomalies found (EM or GPR); surficial contamination	North pasture
B-19	Low		Miscellaneous solid waste, metal, and weapons identified on CSSA's original list, unable to locate.	No anomalies found	West of oxidation pond
Coal Bins	Low		The coal bins are no longer in use, but were used for bulk coal storage.		West of headquarters building
B-5	Low	B/D (if exists)	Area reported to be used as a fired small arms ammunition brass area. This area could not be located during the field survey even though the area had been recently cleared.	No evidence found in field survey	North pasture near gate
B-6	Low		An area near the homesteads and well G (a low spot near the bend in the road) was reported to be used for miscellaneous solid waste, but could not be found.	Site located, but survey not completed	North pasture near the homesteads
B-7	Low	B/Ds	Fired small arms ammunition brass area where it was reported, but not documented, that CSSA personnel found live rounds. Field investigation revealed weapons crates and packing near the road, and numerous types of small caliper ammunition scattered brass throughout the field behind them.	No evidence of subsurface disturbance. Numerous types of small caliber ammunition and scattered brass.	North pasture
B-12	Low	D	Landfill area for large pieces of scrap metal and weapons were embedded in the 20-foot high hillside and in adjacent pond.	No evidence of subsurface disturbance; surface trash, metal and weapons	Behind the F-14 storage area
B-22	High	B/D	Area used to burn artillery shells	No anomalies found	North pasture

B Burning or detonation
D Disposal--depth unknown
Ds Surficial deposition
EM Electromagnetometer
GPR Ground penetrating radar

Table 1.2 Medium Priority Solid Waste Management Units at CSSA

Unit No.	*Status (Priority)*	*Main Use*	*Historic Use (notes from Environmental Assessment, September 1993)*	*Summary of Preliminary Field and Geophysical Results*	*Approximate Location*
B-31	Medium		Sand and lead projectiles from building 90 test range used as pipe bedding	No evidence found in field activities	Northeast of building 92
B-32	Medium		Sand and lead projectiles from building 90 test range used as pipe bedding	No evidence found in field activities	North side of building 34
B-33	Medium		Sand and lead projectiles from building 90 test range used as pipe bedding	No evidence found in field activities	South side of building 45
B-34	Medium		A drain in the locomotive maintenance pit is connected to a pipe which drains into a ditch which leads ultimately to Leon Creek.	No field data yet	Near building 28 (locomotive maintenance building)
B-9	Medium	D	Miscellaneous solid waste (metal and weapons) disposal area. The field survey indicated mildly stressed vegetation, but no indication of ammunition was observed.	No field data yet	Lower east pasture of CSSA
B-25	Medium	D?	Area where a trench was observed in a 1966 aerial photo; no documentation regarding this area was found.	Have not investigated yet	East pasture
B-26	Medium	D?	Area where a trench was observed in a 1966 aerial photo; no documentation regarding this area was found.	Site not identified in survey	East pasture
B-30	Medium		Area where miscellaneous construction debris was disposed of. Field survey indicated scrap concrete, roofing shingles, and construction trash.	No field data yet	Southeast of active facility, behind the quarry
B-13	Medium		Engineering trash dump area. Field survey indicated an area where miscellaneous solid waste was disposed of. This area has been covered sand semi-compacted, but there are several areas where the cover has eroded, revealing the trash.	No field data yet	East of quarry
B-27	Medium		Sanitary landfill	No field data yet	
B-29	Medium	D	Old quarry area used for disposal of miscellaneous solid waste, munitions, and construction debris. A decayed drum of nickel penetrate was observed during the field survey.	No field data yet	Southeast of the munitions maintenance area

B Burning or detonation
D Disposal--depth unknown
Ds Surficial deposition

Table 1.3 High Priority Solid Waste Management Units at CSSA

Unit No.	*Status (Priority)*	*Main Use*	*Historic Use (notes from Environmental Assessment, September 1993)*	*Summary of Preliminary Field and Geophysical Results*	*Approximate Location*
Bldg 43	High	B/Ds	An inactive makeshift ammunition demolition facility used to burn miscellaneous solid waste and ammunition. The area adjacent to Building 43 is covered with molten metal and spent ammunition.	No evidence of subsurface waste activities	Northeast of the oxidation pond
I-1 (Incin-erator)	High	B-paper and trash	Building 294 contains an inactive incine-rator (built in 1943), which is currently used for storage of transformers. Interviews with CSSA personnel indicate that the incinerator was used only to burn paper trash and has been closed since the late 1960s.	No evidence of subsurface waste activities	Adjacent to wastewater treatment facility
B-10	High	D	Ammunition disposal area	No field data yet	North of oxidation pond
B-23	High	D	Area where a trench was observed in a 1966 aerial photo. Field survey indicated a trench filled in with soil, and two green canisters half buried at one end of the trench.	Trenches are obvious	North pasture
B-23A	High	D	Area where a trench was observed in 1994. Glass ampoules filled with a liquid material having different colors.	Two EM anomalies were detected, indicating a subsurface disturbance such as buried waste material.	North pasture

Oxidation Pond at CSSA

Unit No.	*Status (Priority)*	*Main Use*	*Historic Use (notes from Environmental Assessment, September 1993)*	*Summary of Field and Geophysical Results*	*Approximate Location*
O-1	High		An oxidation pond constructed in 1975, however, a relatively small cleared area can be seen in the aerial photo from 1973 (CSSA, 1992). The pond was lined with a vinyl plastic with a life expectancy of 10 years. Waste liquids and sludges were tank-collected from the bluing operation are pumped out and trucked to the evaporation pond. A sample of the top liquid and sludge was taken to Brooks AFB on 20 April 1984 for evaluation at the request of the Texas Department of Health and tested for metals (CSSA, 1984). In 1985, the RRAD prepared a rec-ommended procedure for closure of the evaporation pond (RRAD, 1985). The evaporation pond was filled in with dirt in the fall of 1985 (CSSA, 1992).	Boundaries delineated, roughly circular with 75-ft diameter and depth of less than 5 ft	Inner cantonment area, northeast of main compound

High Priority SWMUs not addressed in the First Portion of this Investigation

Unit No.	***Status (Priority)***	***Main Use***	***Historic Use (notes from Environmental Assessment, September 1993)***	***Summary of Preliminary Field and Geophysical Results***	***Approximate Location***
B-2	High	B/D/Ds	Small arms ammunition burning area used in 1954. Two trenches were observed in historical aerial photos (CSSA, 1991) and confirmed during field study. 57 mm, 128A1 ammunition canisters and fire brick/ammunition piles were observed.	Two trenches confirmed by field investigation; five anomalies found. Ammunition canisters and fire brick/ammunition piles observed.	Outside the security fence line in the north-eastern section of facility
B-3	High	B	Landfill area used primarily for garbage disposal and burning trash that was filled in 1990-91 (CSSA, 1991). The garbage disposal was field verified.	Anomalies detected, therefore subsurface disturbance (300 ft X 125 ft) and (225 ft X 50 ft)	Inner cantonment area northeast of the main compound, and near well 16
B-4	High	B	Classified burn area used to burn classified documents and trash (CSSA, 1991). This area makes up part of a large area of no vegetation surrounding the oxidation pond. Field survey revealed additional SWMUs in the immediate vicinity.	Six anomalies detected; therefore probable ground disturbance. Three are 10-12 ft deep by 20 ft wide at lengths of 100, 200, and 300 ft	Inner cantonment area northeast of the main compound, near well 16, in a large unvegetated area
B-15, B-16	High	B/D (T)	Landfill area for target vehicles and weapons mounts. The area was observed to be two large rectangular areas of settled soil and stressed vegetation. B-16 is in the form of two trenches in which metal objects were visible on the surface, partially covered by soil.	B-15 needs more investigation. B-16 - two large trenches found with major anomalies; small anomalies found also	Near firing range
B-11	High	D	Miscellaneous solid waste disposal area for ammunition, scrap metal, and construction debris. Field survey indicated miscellaneous ammunition boxes and arms packing crates, and construction debris adjacent to the creek.	Evidence of subsurface disturbance/trash on surface	Northwest of building 291
B-24	High	B/Ds	Spent ammunition and small spent rockets were observed during field survey.	A few anomalies found	North pasture
B-28	High	B?/D	Area where trenches of molten metal, small arms ammunition, and metal ammunition parts were disposed of. This area was not visible on aerial photographs, but was observed during the field survey.	Two shallow trenches (300 x 15 ft) and (100 x 15 ft) both approximately 5 ft deep	West of the oxidation pond
DD	High		Dud ammunition disposal area that is well marked with signs, but has not been investigated.	No access allowed to dud area	East of active facility areas

B Burning or detonation
D Disposal--depth unknown
Ds Surficial deposition

1.4 PROJECT TEAM ORGANIZATION

Table 1.4 describes the responsibilities of all key personnel associated with this project. The names of principal personnel associated with this project are listed below.

CSSA Environmental Officer:	Brian Murphy
CSSA Program Assistant:	Michele Silva
AFCEE QAE:	Jo Jean Mullen
Parsons ES Technical Directors:	David Highland
	John Yu
Parsons ES Project Managers:	Susan Roberts
	Julie Burdey
	Ken Rice
	Scott Pearson
Parsons ES Task Manager:	Shavonne Gordon
Parsons ES Office Health and Safety Officer:	Randy Palachek
Parsons ES Field Team Leader:	Scott Pearson
Parsons ES Site Health and Safety Officer:	Kyle Caskey

The site safety organization is structured such that field team members report to the Site Health and Safety Officer who, in turn, reports to the Office Health and Safety Manager for safety-related issues. Subcontractors report to their own health and safety personnel.

The Field Team Leader and Site Health and Safety Officer both have the authority to stop work if an unsafe condition arises. Work will be resumed when the Project Team, and CSSA POC, if necessary, resolve the unsafe condition.

Table 1.4 Personnel Responsibilities

Title	General Description	Responsibilities
CSSA Environmental Officer	Liaison between Parsons ES and AFCEE.	• Notifies AFCEE of any field conditions that may affect the project. • Coordinates field activities of Parsons ES with CSSA installation.
Technical Director	Upper management. Assists project personnel on technical issues.	• Provide technical information for field activities. • Advise Project Manager.
Project Manager	Reports to upper-level management. Has authority to direct response operations. Assumes total control over site activities.	• Prepares and organizes the background review of the situation, the work plan, the site safety plan, and the field team. • Obtains permission for site access and coordinates activities with appropriate officials. • Ensures that the work plan is completed and on schedule. • Briefs the field teams on their specific assignments. • Uses the Site Health and Safety Officer to ensure that safety and health requirements are met. • Prepares the final report and support files on the response activities. • Serves as liaison with public officials.
Office Health and Safety Manager	Advises the Project Manager and Site Health and Safety Officer on safety related issues.	• Oversees preparation of Health and Safety Plan. • Approve HSP. • Provides information regarding project safety issues to Site Health and Safety Officers. • Serves as a liaison with public officials.
Site Health and Safety Officer	Advise the Project Manager on all aspects of health and safety on-site. Stops work if any operation threatens worker or public health or safety.	• Periodically inspects protective clothing and equipment. • Ensures that protective clothing and equipment are properly stored and maintained. • Controls entry and exit at the access control points. • Coordinates safety and health program activities with project safety officer. • Confirms each team member's suitability for work based on a physician's recommendation. • Monitors the work parties for signs of stress, such as cold exposure, heat stress, and fatigue. • Implements the site safety plan. • Conducts periodic inspections to determine if the site safety plan is being followed. • Knows emergency procedures, evacuation routes, and the telephone numbers for ambulance , local hospital, poison control center, fire department, and police department. • Notifies, when necessary, local public emergency officials. • Coordinates emergency medical care. • Sets up decontamination lines and the decontamination solution appropriate for the type of chemical contamination on site. • Controls the decontamination of all equipment, personnel, and samples from the contaminated areas. • Assures proper disposal of contaminated clothing and materials. • Ensures that all required equipment is available. • Advises medical personnel of potential exposures and consequences. • Notifies emergency response personnel by telephone or radio in the event of an emergency.

Title	General Description	Responsibilities
Field Team Leader	Responsible for field team operations and safety.	• Manages field operations. • Executes the work plan and schedule. • Enforces safety procedures. • Coordinates with the Site Health and Safety Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as liaison with public officials.
Work Team	The work party must consist of at least two people, one of whom is a Parsons ES employee.	• Safely complete the onsite tasks required to fulfill the work plan. • Notify project health and safety officer or supervisor of suspected unsafe conditions. Take precautions necessary to prevent injury to themselves and other employees. • Take precautions necessary to prevent injury to themselves and other employees. • Implement the site and personnel air monitoring program. • Comply with Health and Safety Plan. • Maintain visual contact between partners (buddy system). • Perform only those tasks they believe they can do safely. • Immediately report any accidents and/or unsafe conditions to the Field Team Leader, or any deviations from this plan.

SECTION 2

SAFETY AND HEALTH RISK ANALYSIS

Hazardous substances that may be encountered are presented in Table 2.1. In addition to the hazardous chemical substances possibly present at the site, some physical hazards or hazardous conditions may be expected at the site. These include risk of injury while working (slips, trips, and falls), heat and cold exposure, UXO, and biological organisms such as snakes, chiggers and Africanized bees.

During drilling actions via air coring, a substantial amount of particulate matter will be generated and airborne. A particulate MINIRAM™ monitor and an organic vapor monitor will be used to differentiate between level C and level D protection. If the particulate level exceeds 10 mg/m^3 (the threshold limit value [TLV] for limestone dust) or 25 ppm (the TLV for total volatile organic contaminants), respirator protection will be donned. If the particulate level exceeds 250 ppm (the TLV for total volatile organic contaminants), all personnel will stop work and leave the site until conditions subside.

Employees must implement safe work practices while working on-site. Protective clothing will reduce many of the on-site risks. Proper use of protective clothing is described in section 3.4.

2.1 CHEMICAL HAZARDS

Detailed information on the nature of the chemical hazards can be found on the material safety data sheets (MSDSs) and other chemical data in Appendix B. These MSDSs will be available on site and at the Parsons ES office.

Within CSSA, investigative personnel may be exposed to numerous groups of chemical toxicants by both the respiratory and percutaneous (skin absorption) routes. The risk of exposure and the severity of the resultant physiologic reaction to any of the contaminants is determined chiefly by their inherent toxicity, concentration, physical characteristics, duration of exposure, and individual susceptibility or hypersensitivity. The field team may be exposed to contaminants in soils and groundwater through inhalation, ingestion, and skin and eye contact, as detailed below:

- Skin contact with contaminated solid or liquid samples can occur when a worker does not wear proper protective clothing around sampling activities.
- Eye contact with contaminated liquid or solid samples can occur when a worker does not wear protective eye wear at locations where samples are being taken or handled.

- Respiratory system contact with hazardous airborne materials can occur from lack of or improper use of respiratory equipment.
- Gastrointestinal system contact with samples can occur when workers do not pay attention to personal hygiene rules designed to reduce the chance of ingesting site contaminants (e.g., hand washing before smoking, eating, or drinking).

2.1.1 Volatile Organic Compounds

Volatile organic compounds (VOCs) are not suspected at the low or medium priority SWMUs at CSSA. However, since some VOCs can acutely affect the central nervous system, organic vapor monitoring will be conducted at the site. Depending on the degree of exposure and the solvent involved, the effects may range from mild narcosis to death from respiratory failure.

Vapors from VOCs could be encountered during any surface or subsurface soil, or groundwater sampling activity. Organic vapors can build up under confined conditions, such as in a well casing, in any unventilated environment, or even several inches or feet below ground level where there is a solvent source. Organic vapor monitoring will be conducted at least twice daily, during the site field activities that involve sampling and during the construction of each new well. Section 3 of this document outlines monitoring procedures.

2.2 PHYSICAL HAZARDS

While working on site, employees must implement safe work practices in accordance with OSHA regulations. Workers should minimize risks of trips, slips, and falls.

2.2.1 Heat Stress

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. Of particular importance is heat stress resulting when protective clothing decreases natural body ventilation. Heat stress can occur even when temperatures are moderate if employees are wearing impermeable protective clothing. One or more of the following recommendations will help reduce heat stress:

- Provide plenty of liquids to replace body fluids. Water and/or commercial electrolyte mixes should be available on site.
- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.

Table 2.1 Toxicological Properties of Compounds

Compound	LEL[1] (%)	PEL/TLV[2] (ppm)	IDLH[3] (ppm)	Odor Threshold (ppm)	Odor Characteristics	Acute Toxic Effects
Tetrachloroethylene (Perchloroethylene)	N/A	25	150	5	Similar to chloroform, mildly sweet	Irritates eyes, nose, and throat. Causes nausea, flush face, vertigo, dizziness, headache, and incoherency. Cumulative liver, kidney, and central nervous system (CNS) damage. Carcinogen and suspected mutagen.
1,2-Dichloroethylene (*cis* and *trans*)	5.6	200	1,000	N/A	Similar to chloroform, slightly acrid	Irritates eyes, skin, and respiratory system. CNS depressant. Nausea, vomiting, weakness, tremors, and stomach cramps.
Toluene	1.1	50	500	0.036	Sweet, pungent odor (benzene-like), colorless liquid	Irritates eyes and nose. Causes fatigue, weakness, dizziness, headache, dilated pupils, nervousness. Targets skin, liver, kidneys, and CNS. Suspected teratogen and mutagen.
Trichloroethylene	8.0	50	1,000	50	Colorless liquid (sometimes dyed blue) with odor similar to chloroform	Skin and eye irritant. Causes headaches, vertigo, visual disturbances, tremors, nausea, vomiting, and cardiac arrhythmia. Suspected carcinogen, narcotic, anesthetic.
Isopropyl alcohol*	2.0	400	2,000	90	Rubbing alcohol	Mild irritant to eyes, nose, dry cracking skin. Causes drowsiness, dizziness, headache.
Limestone dust	N/A	10 mg/m^3	N/A	N/A	Light dust	Irritates eyes, skin, mucous membranes. Causes coughing, sneezing, rhinitis.
Nickel penetrate	N/A	0.1 mg/m^3	N/A	N/A	N/A	Nausea, vomiting, coughing, convulsions
Lead	N/A	0.05 mg/m^3	100 mg/m^3	N/A	N/A	Heavy, ductile, gray metal. Irritates eyes and causes brain, kidney, blood, CNS, and digestive tract disorders. Symptoms include weakness, insomnia, abdominal pain,

Compound	LEL[1] (%)	PEL/TLV[2] (ppm)	IDLH[3] (ppm)	Odor Threshold (ppm)	Odor Characteristics	Acute Toxic Effects
						colic, constipation, anemia, wrist and ankle paralysis, and low blood pressure.
Black Powder	N/A	N/A	N/A	N/A	N/A	Explosion hazard.
Polycyclic biphenols (PCBs) (Aroclor™ - 1242, Chlorodiphenyl with 42% Chlorine)	N/A	1 mg/m^3 (TLV/PEL)	10 mg/m^3	N/A	Mild hydrocarbon odor	Colorless to pale liquid, viscous liquid or solid. Eye, skin irritant. Affects skin, eyes, liver..
PCB (Aroclor™ - 1254, Chlorodiphenyl with 54% Chlorine)	N/A	0.5 mg/m^3	5 mg/m^3	N/A	Mild hydrocarbon odor	Colorless to pale liquid, viscous liquid or solid. Eye, skin irritant. Affects skin, eyes, liver.
PCB (Aroclor™ - 1260, Chlorodiphenyl with 54% Chlorine)	N/A	0.5 mg/m^3	5 mg/m^3	N/A	Mild hydrocarbon odor	Colorless to pale liquid, viscous liquid or solid. Eye, skin irritant. Affects skin, eyes, liver. Carcinogen.

Source:

[1] NIOSH Pocket Guide to Chemical Hazards, June, 1994

[2] OSHA, 29 CFR 1910.1000, 1989

[3] 1994-1995, American Conference of Governmental Industrial Hygienists (ACGIH)

LEL = Lower explosive limit
PEL = Permissible exposure limit
TLV = Threshold limit value
IDLH = Immediately dangerous to life and health
N/A = not available
* = may be used for decontamination purposes

- Ensure that adequate shelter is available to protect personnel against heat, sun, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.
- Maintain good hygienic standards, frequently changing clothing and daily showering. Clothing should be permitted to dry during rest periods. Workers who notice skin problems and/or heat rash should immediately inform the Site Health and Safety Officer who will in turn consult medical personnel.

Effects of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement, to death. The location of a first-aid manual detailing specific first-aid treatment for mild cases of heat stress should be known at all times by the Site Health and Safety Officer to ensure that it is readily available for reference in the field. Medical help must be obtained for the more serious cases of heat stress.

Heat-Related Problems

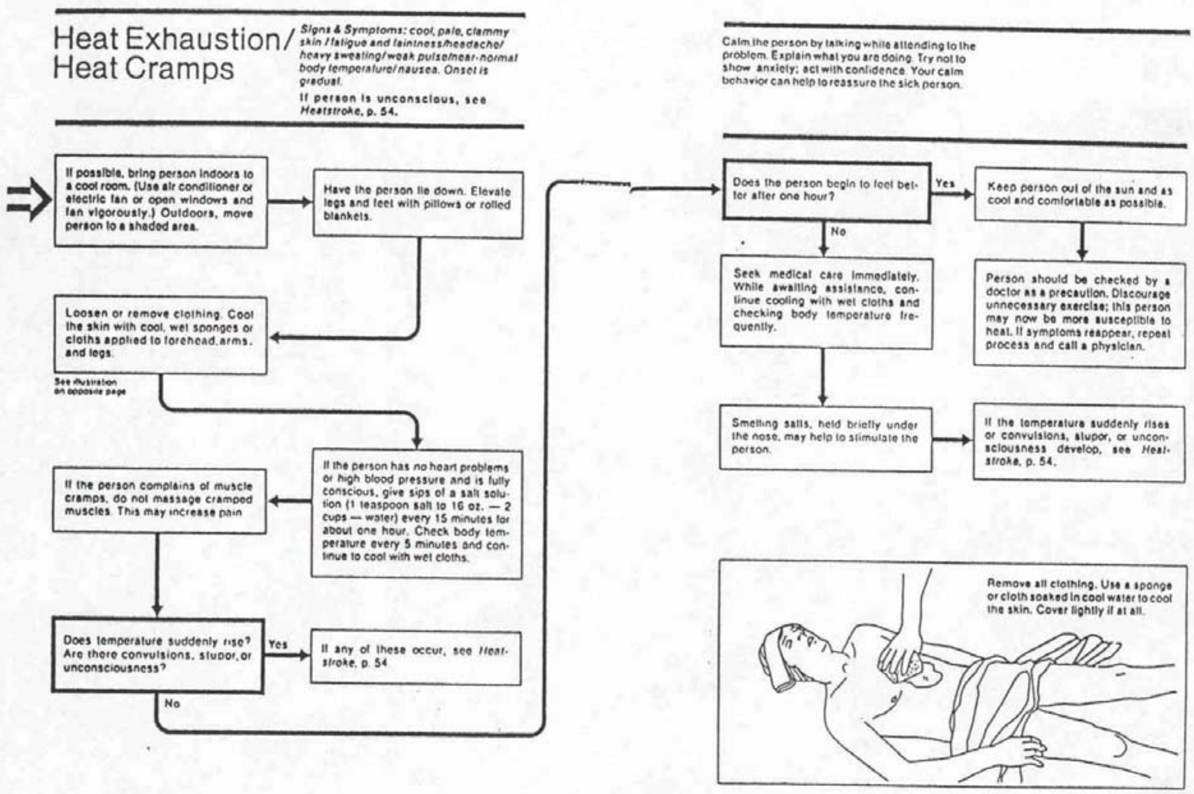
- **Heat rash**: Caused by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.
- **Heat cramps**: Caused by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasms and pain in the extremities and abdomen. Figure 2.1 describes the actions that should be taken to relieve heat cramps.
- **Heat exhaustion**: Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per min.); pale, cool, moist skin; profuse sweating; and dizziness and lassitude. Figure 2.1 describes the actions that should be taken to relieve heat exhaustion.
- **Heat stroke**: The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse; and possibly coma. Medical help must be obtained immediately. Figure 2.2 describes the actions that should be taken in route to the hospital or while waiting for an ambulance.

Heat-Stress Monitoring

Monitoring of personnel wearing impervious clothing may begin when the ambient temperature is 70°F or above. Monitoring of heat stress for other working conditions will occur at the worker's request, at the discretion of the Site Health and Safety Officer, or as conditions change. Table 2.2 presents the suggested frequency for such monitoring.

Figure 2.1 Medical Procedures for Heat Exhaustion/Heat Cramps

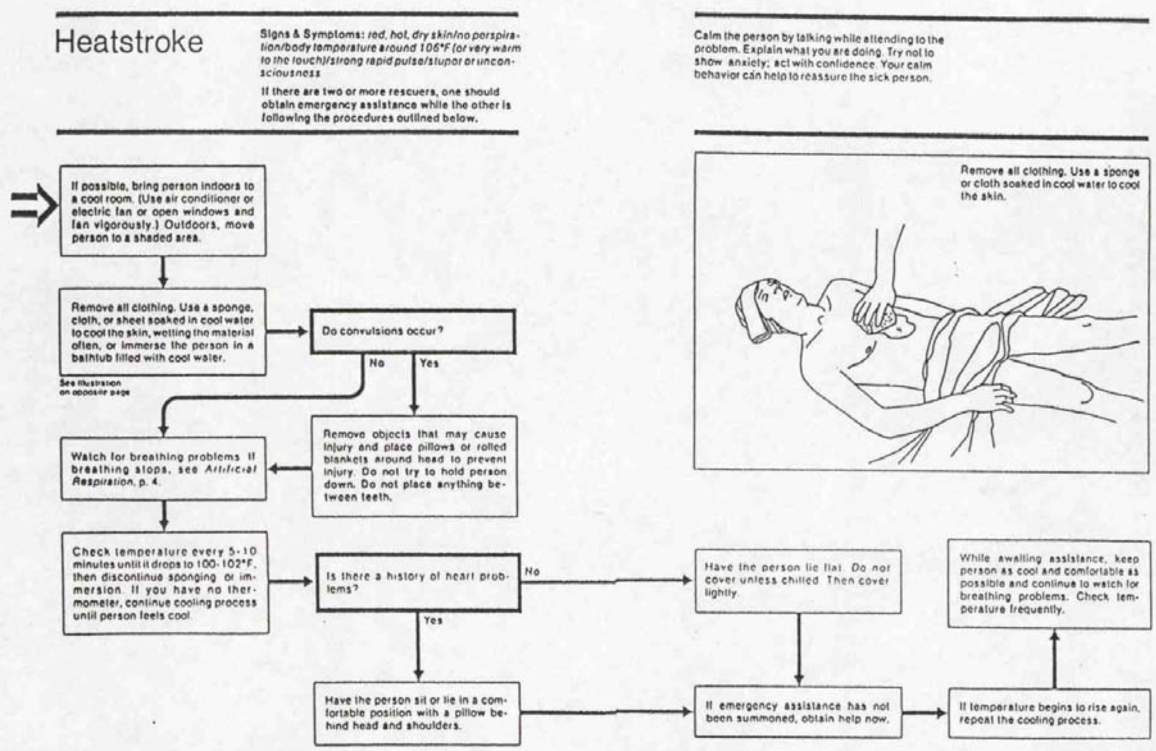
Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.



Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.

Figure 2.2 Medical Procedures for Heatstroke

Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.



Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.

Table 2.2 Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[1]

Temperature	Normal Work Ensemble[2]	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5-90°F (30.8-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5-87.5°F (28.1-30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5-82.5°F (25.3-28.1°C)	After each 90 minutes of work	After each 90 minutes of work
72.5-77.5°F (22.5-25.3°C)	After each 150 minutes of work	After each 120 minutes of work

[1] For moderate work, e.g. walking about with moderate lifting and pushing.
[2] A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

Monitoring frequency will increase as the ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with a current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative abilities from excess heat, one or more of the techniques listed below will be used. Other methods for determining heat-stress monitoring, such as the wet bulb globe from the American Conference of Governmental Industrial Hygienists TLV Booklet, may be used.

To monitor the worker, measure:

- **Heart rate**: Count the radial pulse during a 30-second period as early as possible during the rest period.
  - If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
  - If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- **Oral Temperature**: Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
  - If oral temperature exceeds 99.6°F (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
  - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following cycle will be reduced by one-third.
  - No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

2.2.2 Cold Exposure

Persons working in temperatures at or below freezing may suffer from cold exposure. During prolonged outdoor periods with inadequate clothing, effects of cold exposure may even occur at temperatures well above freezing. Cold exposure may cause severe injury by freezing exposed body surfaces (frostbite) or result in profound generalized cooling (hypothermia), possibly causing death. Areas of the body that have high surface-area-to-volume ratios, such as fingers, toes, and ears, are the most susceptible to frostbite.

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of damage. Frostbite of the extremities can be categorized into:

- **Frost nip or incipient frostbite**: characterized by suddenly blanching or whitening of skin.
- **Superficial frostbite**: skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- **Deep frostbite**: tissues are cold, pale, and solid; extremely serious injury.

Systematic hypothermia is caused by exposure to freezing or rapidly dropping temperature. Its symptoms are usually exhibited in five stages: (1) shivering and incoordination; (2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F; (3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; (4) freezing of the extremities; and (5) death.

If work is conducted at ambient temperatures below 39°F (4°C), workers shall wear cold protective clothing appropriate for the level of cold and physical activity. If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.

If work is to be performed at temperatures below 20°F, heated shelters shall be made available, and employees will break to seek warmth at regular intervals, the frequency depending on the severity of exposure. The onset of shivering will require immediate return to the warm shelter for a period of time necessary for the employee to warm up. Figure 2.3 describes the actions that shall be taken when an employee is suffering from cold exposure.

Evaluation and Control

For exposed skin, continuous exposure shall not be permitted when the air speed and temperature result in an equivalent chill temperature of -32°C (-25.6°F). Superficial or deep local tissue freezing will occur only at temperatures below -1°C (30.2°F) regardless of wind speed.

Guidelines recommended for properly clothed workers for periods of work at temperatures below freezing are shown in Table 2.3.

Special protection of the hands is required to maintain manual dexterity for the prevention of accidents:

- If fine work is to be performed with bare hands for more than 10 to 20 minutes in an environment below 16°C (60.8°F), special provisions shall be established for keeping the workers' hands warm. Metal handles of tools and control bars shall be covered by thermal insulating material at temperatures below -1°C (30.2°F).
- If the air temperature falls below 16°C (60.8°F) for sedentary, 4°C (39.2°F) for light, or -7°C (19.4°F) for moderate work, and fine manual dexterity is not required, then gloves shall be worn.

To prevent contact frostbite, the workers shall wear anti-contact gloves.

- When cold surfaces below -7°C (19.4°F) are within reach, a warning shall be given to each worker by the supervisor to prevent contact by bare skin.
- If the air temperature is -17.5°C (0°F) or less, the hands shall be protected by mittens. Machine controls and tools for use in cold conditions shall be designed so that they can be handled without removing the mittens.

Figure 2.3 Medical Procedures for Cold Exposure

Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.

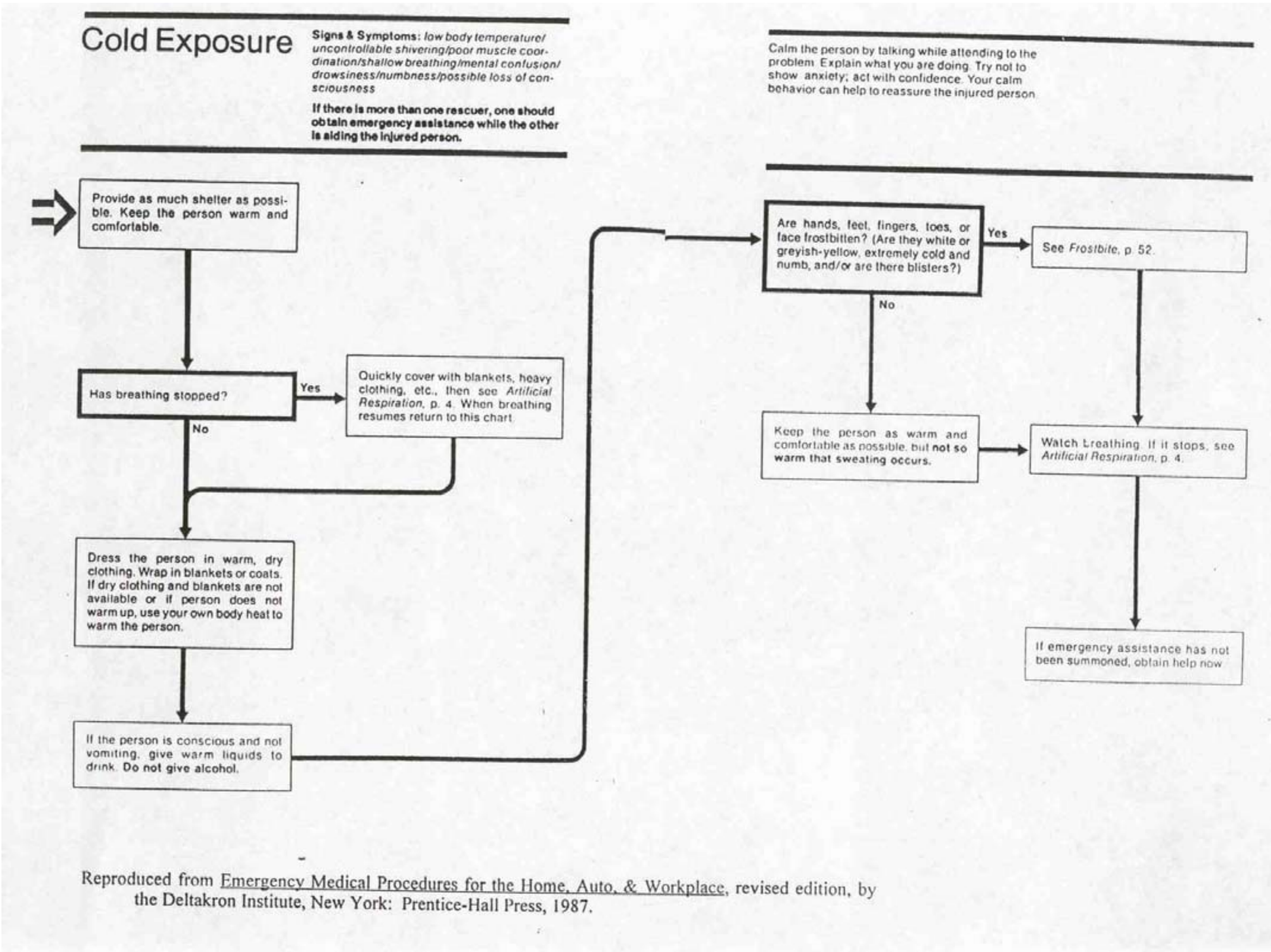
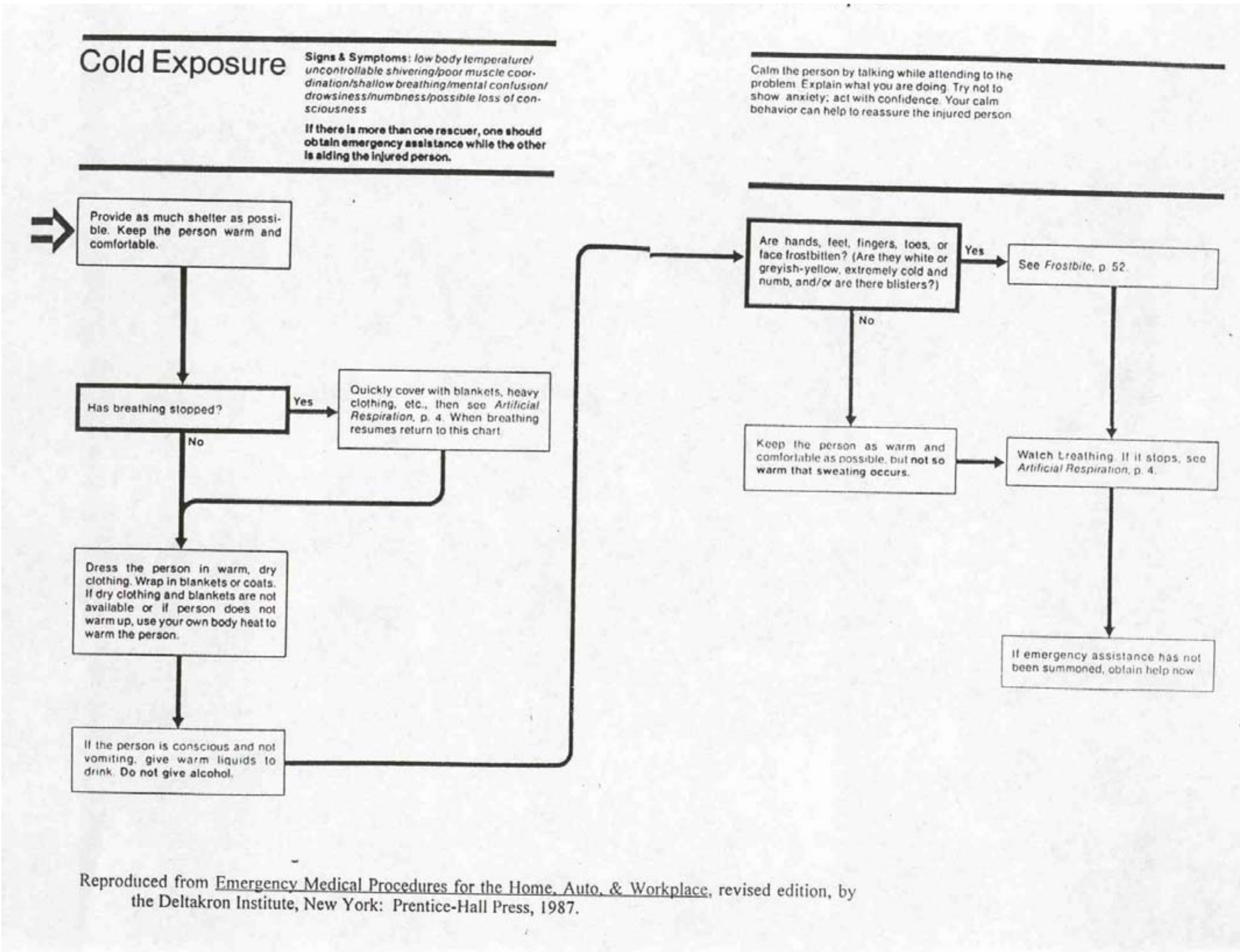


Table 2.3 Wind Chill Factors

Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.



Provisions for additional total body protection are required if work is performed in an environment at or below 4°C (39.2°F). The workers shall wear cold protective clothing appropriate for the level of cold and physical activity:

- If the air velocity at the job site is increased by wind, draft, or artificial ventilating equipment, the cooling effect of the wind shall be reduced by shielding the work area or by wearing an easily removable windbreak garment. If only light work is involved and if the clothing on the worker may become wet on the job site, the outer layer of the clothing in use may be of a type impermeable to water. With more severe work under such conditions, the outer layer shall be water repellent, and the outerwear shall be changed as it becomes wetted. The outer garments shall include provisions for easy ventilation in order to prevent wetting of inner layers by sweat. If work is done at normal temperatures or in a hot environment, before entering the cold area, the employee shall make sure that clothing is not wet as a consequence of sweating. If clothing is wet, the employee shall change into dry clothes before entering the cold area. The workers shall change socks and any removable felt insoles at regular daily intervals or use vapor barrier boots. The optimal frequency of change shall be determined empirically and will vary individually and according to the type of shoe worn and how much the individual's feet sweat.
- If exposed areas of the body cannot be protected sufficiently to prevent sensation of excessive cold or frostbite, protective items shall be supplied in auxiliary heated versions.
- If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work shall be modified or suspended until adequate clothing is made available or until weather conditions improve.
- Workers handling evaporative liquid (i.e., decontamination solvents) at air temperatures below 4°C (39.2°F) shall take special precautions to avoid soaking of clothes or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

2.2.3 Snake and Africanized Bee Hazards

Snakes and Africanized bees may be encountered at the site. Workers should use caution and avoid walking in overgrown areas. Field team members who are allergic to bee or wasp stings shall notify the Site Health and Safety Officer prior to initial field work.

If a worker is bitten, the following steps should be taken:

- Keep the victim calm.
- Minimize movement.
- Apply ice to the area bitten being careful not to freeze the tissue.
- Transport victim from the site. The victim should then be transported to the nearest medical facility.

2.2.4 Poison Ivy

Skin contact with poison ivy can cause swelling, breathing difficulty, blisters, fever, and severe itching. Poison ivy commonly grows along creek banks and is poisonous year-round. To prevent contact with poison ivy, personnel should wear long sleeves, long pants and gloves. If contact is suspected, the affected area shall immediately be washed with soap and water and clothes shall be changed. Poison ivy oils may remain on clothing or equipment until they are washed. Figure 2.4 describes poison ivy and steps that shall be taken if a person has had skin contact with poison ivy. The initial health and safety briefing will discuss possible poisonous plants at CSSA.

2.2.5 Noise

High noise levels are anticipated to be found in the vicinity of operating drilling equipment and other heavy machinery. Field personnel shall use the approved and appropriate hearing protection when working in these areas. Unprotected long-term exposure to noise above 85 decibels (dB) can result in hearing loss.

2.2.6 Chiggers and Ticks Hazards

Chiggers may be encountered at the site. Chigger bites cause intense itching and the affected skin tissue becomes red and swollen. Protection with repellents is the best means of reducing chigger bites. If exposed to chigger-infested areas, immediately take a hot soapy bath to kill and remove chigger larvae, then apply an antiseptic to welts to prevent infection.

There are three species of ticks common to Texas and may be encountered at the site. In addition to dermatosis caused by tick bites, ticks can transmit diseases by infecting hosts. Possible diseases carried by ticks are Rocky Mountain spotted fever, tularemia, and Lyme diseases.

Level D personal protective equipment (PPE) is expected to provide sufficient protection from chiggers and ticks. If chiggers and tick bites are encountered requiring more attention than first aid, the field team member will seek medical treatment.

2.3 HAZARD EVALUATION

To ensure a strong safety awareness program during site prescreening, geophysical surveying, drilling, and sampling, personnel must have adequate training; this health and safety plan must be communicated to the employees; and standing work orders must be developed and communicated to the employees. Sample standing orders for personnel working at the site are as follows:

- Do not touch, kick or pick up any unidentified objects on the ground.
- If a UXO is encountered STOP WORK in this area, evacuate the site, inform the Site Health and Safety Officer, Project Manager and the CSSA Environmental Officer or his designee of the findings. Stake around the perimeter of the SWMU. No unauthorized personnel will be allowed in the area. At this time the Health and Safety Plan will be amended as necessary.

- Avoid leaning, sitting, or kneeling on contaminated surfaces.
- No touching, kicking or disturbing any metal debris or any other containers.
- No smoking, eating, or drinking at the site.
- No matches or lighters at the site.
- No personal vehicles at the site.
- Use buddy system at all times.
- Wear appropriate personal protective equipment.
- Avoid walking through puddles or stained soil.
- Discovery of unusual or unexpected conditions will result in immediate evaluation and reassessment of site conditions and health and safety practices.

Figure 2.4 Medical Procedures for Poison Ivy, Oak, and Sumac

Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.

45 Poison Ivy, Oak, & Sumac

Remove affected clothing and flush contact area with water. Wash thoroughly with warm water and soap, then swab with alcohol soon after exposure.

Has the person inhaled smoke from burning poison plants?

Yes: Seek medical care, or if person is unable to walk, obtain emergency assistance. If assistance will be delayed and person is having difficulty breathing, give antihistamine (Contac, Dristan, etc.).

If breathing stops, see *Artificial Respiration*, p. 4.

No: If external rash and blisters appear, apply cold, wet compresses, then calamine lotion taking care near eyes. For heavy blistering and oozing, use cold, wet compresses of 1 Tbs. salt to 1 cup of water.

If serious swelling, breathing difficulty, blisters, fever, severe itching, or other reaction occurs, seek medical care.

Calm the person by talking while attending to the problem. Explain what you are doing. Try not to show concern; act with confidence. Your calm behavior can help to reassure the injured person.

Recognize common poison plants:

Poison Ivy
Small plant, vine, or shrub common throughout U.S. except California. Shiny leaves grow in clusters of three, turning red and yellow toward Fall.

Poison Oak
Western variety grows in California and portions of adjacent states as shrub or vine closely resembling poison ivy.
More common variety grows in other areas, usually as a shrub with clusters of hairy, yellowish berries and undersides of leaves covered with hair.

Poison Sumac
Woody shrub or small tree (5-25 feet) grows in eastern U.S., especially in moist climates.
Each leaf stalk has 7-13 leaflets with smooth edges, which turn red in Fall, and cream-colored berries which hang from branches in loose clusters.

Reproduced from Emergency Medical Procedures for the Home, Auto, & Workplace, revised edition, by the Deltakron Institute, New York: Prentice-Hall Press, 1987.

- Conduct safety briefings daily prior to on-site work. All health and safety briefings must be documented in the field logbook and checked daily by the Site Health and Safety Officer.
- Take precautions to prevent injury from heavy equipment and other tools.
- Only qualified operators will be allowed to operate heavy equipment.

If climbing activities are required, conditions of the footing and the need for spotting will be determined prior to initiating the climb. Prior to any field activities, the Parsons ES project health and safety officer will hold an initial health and safety briefing. Each employees and subcontractor scheduled to be on-site during the survey must attend an initial health and safety briefing. Topics to be discussed at this briefing will include specific procedures and protocol for working at SWMUs; a description of the site chemical hazards and toxicological properties of chemicals; a description of physical hazards, such as heat stress, cold-related illness, Africanized bees, etc., and how to avoid them; personal protective equipment; and emergency procedures. In addition, a brief health and safety meeting will be held each day prior to starting field activities. Both these briefings and the initial health and safety meeting will be documented in the field logbook.

Site visitors and noncontractor oversight personnel will attend the brief health and safety meeting prior to site visit. These personnel may not enter the exclusion zone unless they have proof that they have completed training that satisfies the requirements of 29 CFR 1910.

2.3.1 Geophysical Survey

Prior to collecting surface geophysical data, a grid system will be established at each site which will encompass the areas of suspected ground disturbance. Staking out of the site and the geophysical survey will be performed in Level D. Heat stress, trips, slips, falls, snakes, and bees will be the physical dangers of concern. Many of these topics are discussed Section 2.2. The geophysical survey does not involve disturbing the soil and, therefore, chemical exposure will be limited.

2.3.2 Drilling/Well Installation

Field team leaders are experienced in drilling safety and good engineering practices detailed in the Parsons ES Drilling Safety Guide. This guide has been prepared using information gathered from delegations of the Drilling Care Drill Manufacturers Association and the National Drilling Contracts Association. Safe drilling operations specified in this guide are: housekeeping on and around the drilling rig, maintenance safety, safe use of hand tools, start-up, safety during drilling operations, safe use of augers, etc. Basic practices to be used for the drilling effort expected at CSSA are in the following discussion.

Efforts will be made prior to mobilization of the drilling equipment to determine if underground installations (i.e., sewers, telephone, water, fuel, electrical lines, or liners) are present in the vicinity and, if so, exactly where such underground installations are located. Drilling locations may be adjusted in the field to avoid underground

obstructions. Based on Parsons ES previous experience and information from CSSA personnel, none of the sites to be investigated are expected to have underground installations in the vicinity.

The drilling rig is heavy equipment, and all field personnel must also be careful in the drilling area. The rig is used to hoist and turn augers, drill rods, hammers, and other heavy tools or equipment. Parsons ES personnel should be visible to the drilling rig operators when working near the rig. A hard hat, safety glasses, ear protection, and steel-toed boots must be worn by all personnel within 50 feet of the drilling rig.

All equipment on the rig will be inspected periodically by the drillers as required by applicable guidance regulations for conditions of ropes, cables, hooks, U-bolts or other hoisting harnesses which, if defective, it may drop heavy objects on individuals working in the vicinity of the rig.

Low and medium priority SWMU drilling will be performed in Level D PPE since volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) are not expected to be present in the breathing zone. However, air monitoring for VOC and levels of limestone dust (air-borne particulates) will be performed during drilling. Non-drilling personnel will be instructed to stay upwind of the limestone dust plume anticipated to result from drilling. PPE is further described in section 3.4. Drilling in the oxidation pond will be started in Level C PPE because of suspected VOC contamination. Air monitoring will be performed with a photoionization detector (PID) or an flame ionization detector (FID). In the event air monitoring indicates Level C is not necessary, the Site Health and Safety Officer, in conjunction with Parsons ES Austin health and safety officer, may allow Level D PPE.

Airborne dust is the primary route of exposure to metals. All employees on site will avoid exposure to excessive dust particles. Monitoring with an air particulate meter (MINIRAM™) will be performed. If particulate levels reach the action levels specified in Table 3.1, respiratory protection and goggles will be donned. All drilling and sampling personnel will wear gloves to prevent exposure through skin adsorption.

2.3.3 Surface Soil, Surface Water, Groundwater, and Sediment Sampling

Field personnel shall be cautious of splash hazards when obtaining soil, sediment, and water samples. Use of the appropriate PPE will help to minimize risks of liquid contact with the skin. Personnel shall wear modified Level D PPE during sampling. Since they will not be working near a drilling rig, hard-hats will not be necessary.

Samples will be collected using decontaminated sampling equipment. Disposable nitrile gloves will be worn and changed between collection of samples. If samples appear to be contaminated, outer nitrile gloves will be donned.

Vapors from VOCs could be encountered during any surface or subsurface soil, or groundwater sampling activity. Organic vapors can build up under confined conditions, such as in a well casing, in any unventilated environment, or even several inches or feet below ground level where there is a solvent source. An organic vapor monitor will be used to differentiate between level C and level D protection. If the vapor concentration

exceeds 25 ppm (the TLV for Total Volatile Organic Contaminants), Level C PPE is required. If the particulate level exceeds 250 ppm (the TLV for Total Volatile Organic Contaminants), all personnel will stop work and leave the site until vapors disperse.

Areas where sediment and surface water samples are obtained are frequently wet and can result in slip, trip, and fall hazards. Field personnel will survey each sample collection location to determine the safest route and method of sampling.

Material safety data sheets for approved solvents and contaminants of concern are contained in Appendix B of this plan. If other solvents are required, field team members must obtain a MSDS and approval of the Site Health and Safety Officer prior to bringing the solvent to the work site. The solvents must be added to the Health and Safety Plan.

The sampling team for this portion of the work will consist of a minimum of two Parsons ES personnel. The surface water samples will be collected with an appropriate sampler from outside of the surface water body.

2.3.4 Mapping

Prior to field activities, each SWMU will be mapped during an initial visit.. Heat stress, trips, slips, falls, snakes, and bees will be the physical dangers of concern. Many of these topics are discussed Section 2.2. Mapping does not involve disturbing the soil and, therefore, chemical exposure will be limited.

2.3.5 Soil Gas Survey

Efforts will be made prior to conducting the soil gas survey to determine if underground installations (i.e., sewers, telephone, water, fuel, electrical lines, or liners) are present in the vicinity and, if so, exactly where such underground installations are located. A preliminary site visit and records search did not indicate the presence of any underground or overhead lines (ES, 1993). Soil gas locations may be adjusted in the field to avoid underground obstructions.

All field personnel must be careful in the soil gas survey area. Steel-toed boots, ear plugs, and safety glasses must be worn by all personnel while using the pneumatic hammer.

Low and medium priority SWMU soil gas surveys will be performed in Level D PPE since VOCs and SVOCs are not expected in the breathing zone. However, air monitoring for VOCs will be performed during soil gas surveys. PPE is further described in section 3.4.

2.3.5.1 Soil Gas Analytical Equipment

Soil gas samples will be analyzed with an HNu™ model 321 GC equipped with an electron-capture detector (ECD) and a photoionization detector (PID) with a 10.2 eV light source. A Spectra-Physics model 4400 dual-channel integrator will be used to plot the chromatograms, to measure the size of the peaks, and to compute compound concentrations.

The ECD contains a radioactive nickel-63 foil with a source strength of 5 millicuries. This source decays by emitting beta particles at a maximum energy of 0.063 million

electron volts (MeV) and are absorbed by less than 1 milligram per centimeter squared (mg/cm^2) of aluminum. There is no discernible radiation from the nickel-63 source external to the detector chamber and no hazard as long as the chamber integrity is not violated. A current leak test certification will be maintained on site. The shipment of the ECD to and from the site shall comply with DOT regulations. The instrument is operated under a general license for radioactive sources.

SECTION 3

PERSONNEL PROTECTION AND MONITORING

3.1 GENERAL SAFETY TRAINING REQUIREMENTS

All personnel involved in the project field work must be adequately trained and thoroughly briefed on anticipated hazards, equipment to be worn, safety practices to be followed, emergency procedures, and communications.

Where required based on scope of work, site personnel will be trained in accordance with OSHA requirements as contained in 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response. Employees will not participate in field activities until they have been trained to the level required by their job function and responsibility. In addition, at least one person involved in field investigation activities will have completed Red Cross or equivalent first-aid and cardiopulmonary resuscitation (CPR) courses. All training documentation will be verified by the Site Health and Safety Officer.

Consistent with OSHA 29 CFR 1910.120, individuals designated as site health and safety supervisors must receive an additional eight hours of specialized training on managing hazardous waste operations. Such training will also be documented.

3.2 MEDICAL SURVEILLANCE

Parsons ES uses the services of a licensed occupational health physician (Medical Services Network) with knowledge of or experience in the hazards associated with the work to perform the medical examinations and surveillance specified herein. The medical monitoring program meets the requirements of 29 CFR 1910.120. Parsons ES also requires that subcontractors have their own annual medical monitoring program, as necessary.

Personnel involved in this operation undergo medical surveillance at 12-month intervals. The medical exam is performed under the direction of a licensed occupational health physician, who issues a medical certification of each worker's fitness or unfitness for employment on hazardous waste projects, identifying any restrictions on worker activity that may be indicated. This evaluation will be repeated as indicated by substandard performance or evidence of particular stress that is evident by injury or time-loss illness on the part of any worker.

3.3 SITE-SPECIFIC TRAINING

The Site Health and Safety Officer and Field Team Leader will be responsible for developing a site-specific occupational hazard training program and for training all Parsons ES personnel who are to work at CSSA. This training will specifically address the activities, procedures, monitoring, and equipment applicable to the site's operations as well as, site layout, potential hazards, and emergency response services at the site. Individual responsibilities regarding health and safety procedures during field work will be clarified. Additional topics that will be addressed at the first safety briefing, and at subsequent briefings as necessary, include:

- Names of personnel responsible for site safety and health;
- Safety, health, and other hazards at the site;
- Exposure risk;
- Proper use of personal protective equipment;
- Decontamination procedures to be followed;
- Location of safety equipment;
- Work practices by which the employee can minimize risk from hazards;
- Safe use of engineering controls and equipment on the site;
- Acute effects of chemicals at the site;
- Accident reporting;
- Emergency and evacuation procedures;
- Review of planned activities.

One member of the field team must document that all of the above listed topics were addressed.

All personnel on the job will receive initial site-specific safety training. Safety briefings will also be held daily. Both the initial health and safety training and the daily briefings will be documented in the field logbook. Documentation will include topics discussed and the names of personnel attending the briefing.

3.4 PERSONAL PROTECTIVE EQUIPMENT AND ACTION LEVELS

Paragraph 1910.132[f] of the new OSHA standard, effective July 4, 1994, requires employers to train employees in the proper use of their PPE. Employee training will consist of the following:

- When PPE is necessary;
- What type of PPE is required;
- How to properly don, doff, adjust, and wear PPE;

- The limitations of the PPE; and
- The proper care, maintenance, useful life, and disposal of PPE.

OSHA requires employer verification of training through a written certification. Since these topics will be covered in the initial safety briefing and periodically during daily safety briefings, signatures on the plan acceptance form and on the daily briefings attendance forms (Appendix A) will constitute written certification of this training.

3.4.1 Level D Operations

Level D (no respiratory protection) may be used when the workplace atmosphere contains no potential respiratory hazard and when work functions do not involve splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

Most of the field work conducted at each SWMU site will be conducted in Level D-modified. Depending on the nature of the work being performed, protective clothing may also consist of Tyvek* suits, protective gloves, and other protective clothing as described below. Level D-modified consists of:

- Tyvek or similar disposable coverall (optional): For use during any field activity which requires that personnel come into contact with soil or water;
- Inner gloves (nitrile) as determined: For use during any field activity which requires that personnel come into contact with soil or water;
- Outer gloves such as nitrile or neoprene (optional): For use during any field activity which requires that personnel come into contact with contaminated soil and water;
- Rubber or leather steel toed, steel shank boots (chemical-resistance is optional): Mandatory for all field investigation activities;
- Safety glasses with side shields: For use during all drilling and sampling activities;
- Hearing protection (when working in a noisy environment such as within 50 feet of drilling equipment);
- Hard hat (when working around heavy equipment): Mandatory for all personnel working adjacent to an operating rig and in the exclusion zone; and
- Additional items may be required in specific locations or tasks.

Dust masks or some other form of respiratory protection with dust protection cartridges will be donned if the particulate level exceeds 10 mg/m^3. The particulate level will be measured with a MINIRAM™.

Respiratory protection will not be required if the concentration of Total VOCs is below 25 ppm. If the concentration of Total VOCs is above 25 ppm, colormetric tubes will be used to measure the concentrations of the constituents of concern. Total VOCs are measured with a PID or FID. If the concentration of total VOCs exceeds 250 ppm, all

personnel shall stop work and leave the area. See Table 3.1 for the action levels for implementing C and D levels of protection. Contaminant concentrations can be controlled using engineering controls (ventilation, wetting, etc.) to allow the use of a lower level of protection, provided that monitoring shows that the concentrations have been reduced to the appropriate ranges.

Drilling actions in the oxidation pond will be started in level C PPE because of suspected VOC contamination. If in the event air monitoring indicates Level C as not necessary, the Site Health and Safety Officer, in conjunction with Parsons ES Austin designated health and safety officer, may allow Level D PPE.

3.4.2 Level C Operations

Personnel conducting field activities when air monitoring indicates the action levels specified in Table 3.1 have been met will upgrade to level C PPE. Personnel will use only National Institute of Occupational Safety and Health (NIOSH) approved particulate and organic vapor respirators if monitoring indicates respiratory protection is required. Respiratory protection shall follow the requirements contained in the OSHA standard 29 CFR 1910.134 and American National Standards Institute standard Z88.2-1969.

3.4.3 PPE and Equipment Decontamination Procedures

Decontamination procedures are required as equipment may come into contact with chemicals listed in Table 2.1

An exclusion zone (EZ), contamination reduction zone (CRZ), and support zone (SZ) will be established whenever field personnel are using PPE. Defined boundaries (access and egress points) will be established whenever feasible, and personnel will enter and exit only through these points. In addition, all personnel who are involved in daily field investigations will be required to shower as soon as possible after leaving for the day.

All equipment that requires decontamination will be decontaminated according to the procedures described in the Field Sampling Plan. Decontamination procedures will be monitored by the Site Health and Safety Officer (SHSO).

3.4.3.1 Decontamination Equipment

Equipment decontamination will take place on-site and may generate liquids from washing and rinsing procedures. All liquids will be containerized, sampled, and disposed as stated in the approved work plan. If substantial contamination is found, liquids will be collected and contained for appropriate disposal. Changes in the equipment used for decontamination may be made at the discretion of the SHSO. Decontamination equipment will include:

- Plastic buckets and pails
- Scrub brushes and long-handled brushes
- Detergent (e.g., Alconox)
- ASTM type II deionized water
- Isopropyl alcohol
- Paper towels
- Plastic garbage bags
- Potable water
- Disposal drums
- Plastic liner material
- Hand pump sprayer
- Eye wash

Table 3.1. Action Levels for Personnel Protective Equipment.

Air Monitoring Action Levels

Action Level (Concentration of Organic Vapor in Breathing Zone)	Method of Detection	Action
	Oxidation Pond	
< 25 ppm Total VOC	PID or FID	Downgrade to Level D protection
≥ 250 ppm Total VOC	PID or FID	Stop work. Leave the site until conditions subside.
>10% LEL	Combustible Gas Analyzer	Stop work. Leave the site until conditions subside.
> 10 mg/m^3 limestone particulates	MINIRAM™	Leave area or upgrade to respiratory particulate protection.
	All SWMUs except the Oxidation Pond	
25-50 ppm Total VOC < 25 ppm Tetrachloroethylene	PID or FID Colormetric Tubes	Level D PPE
25-50 ppm Total VOC ≥ 25 ppm Tetrachloroethylene	PID or FID Colormetric Tubes	Leave area or upgrade to Level C personal protective equipment.
50-250 ppm Total VOC	PID or FID	Leave area or upgrade to Level C personal protective equipment.
≥ 250 ppm Total VOC	PID or FID	Stop work. Leave the site until conditions subside.
>10% LEL	Combustible Gas Analyzer	Stop work. Leave the site until conditions subside.
> 10 mg/m^3 limestone particulates	MINIRAM™	Leave area or upgrade to respiratory particulate protection.

Notes:

VOC - Volatile organic concentration
PID - Photoionization detector
FID - Flame Ionization detector

3.4.4 Equipment Needs

The field team will have the following items readily available:

- Copy of this site health and safety plan;
- First aid kit;
- Eyewash bottle;
- Eye protection (as necessary);
- Potable water;
- Hard hat (as necessary);
- Hearing protection;
- Fire extinguisher (type A, B, C);
- Adequate supply of PPE; and
- Decontamination supplies.

3.4.5 Monitoring Requirements

During drilling, air monitoring for VOCs, explosive vapor monitoring, and particulates will be performed by Parsons ES personnel. Monitoring methods to detect exposure for specific contaminants must take into account the expected concentrations and species of contaminants, and the limitations and advantages of available methods. Only Level D PPE will typically be necessary during field actions other than when drilling within the oxidation pond.

Particulate Monitoring

The real-time air/dust monitor (MINIRAM™) should be operated in a temperature range of 32°F to 120°F. At least 10 seconds are required for each reading. With a complete charge, the unit is operable for 10 hours, but the total measurement period is $8^{1}/_{3}$ hours. The monitor will be zeroed to background before use in an upwind area.

If air rotary drilling method is used, monitoring for particulates will be done continuously. If an auger rig is implemented, the field team can monitor for particulates as necessary.

Organic Vapor Monitoring

Organic vapor monitoring, using a PID or FID, will be performed prior to the start of work, periodically during work, and as working conditions change. Colormetric tubes will be used to identify organic vapors when necessary, but are not considered an accurate means of determining exposure levels.

If the levels of organic vapor are at or above action levels, increased monitoring will be initiated. Monitoring will take place at a frequency and pattern needed to represent the levels of exposure of all the field team members. Where exposures are above the TLV, monitoring will assure the adequacy of respiratory selection and the effectiveness of engineering controls. If above the TLV, the protection level must be upgraded and

respirators are necessary. Personal air monitoring will take place if organic vapors are above the TLVs, and at least twice during the project using more specific methods than colorimetric tubes.

Either a PID or a FID will be used as the initial indicator of possible exposure to organic vapors.

Combustible Gas/Explosive Environment Monitoring

An explosivity meter (oxygen/combustible gas meter), HMX271 combustible gas indicator, will be used during excavation and drilling operations for measuring combustible gas levels. The instrument is portable, lightweight, fully automatic, and provides characteristic warning signals when unacceptable levels of combustible gas are detected. The instrument can detect combustible concentrations up to the lower explosive limit.

NIOSH has established the following guidelines concerning working in an explosive environment:

- If explosivity readings are detected between 10-25 percent LEL, then work activities in the area should be limited to those that do not generate sparks.
- If the explosivity readings on the combustible gas indicator is above 25 percent, operations will terminate and the on-site area must be immediately evacuated until appropriate action can be taken to eliminate the hazard.

These guidelines will be followed during the monitoring for explosive environments. Once the site has been evacuated, the resumption of on-site activities will not occur until the SHSO has consulted with personnel experienced in fire or explosion hazards.

3.5 LOW AND MEDIUM PRIORITY SWMU

3.5.1 Geophysical Survey

Level D PPE will be used for geophysical survey. If there are no overhead dangers, hard-hats will not be required.

3.5.2 Drilling/Well Installation

Level D PPE will be used for drilling and well installation unless high levels of VOCs are detected with the PID/FID. Eye and ear protection should be worn around drilling rigs at all times.

3.6 HIGH PRIORITY SWMU

3.6.1 Geophysical Survey

Level D PPE will be used for geophysical survey. If there are no overhead dangers, hard-hats will not be required. Level C PPE is not required for performing a geophysical survey in a high priority SWMU because the ambient air should not exceed action levels specified in Table 3.1. Personnel will not enter the incinerator during field activities.

3.6.2 Soil Gas Survey

Level D PPE will be used for soil gas surveys. Eye and ear protection will be worn at all times while using pneumatic hammer. Hard-hats are not required unless there is an overhead danger.

SECTION 4

SITE CONTROL MEASURES, ACCIDENT PREVENTION, AND CONTINGENCY PLAN

4.1 SITE CONTROL MEASURES

The following site control measures will be followed to minimize potential contamination of workers, protect the public from potential site hazards, and control access to the sites. Site control involves the physical arrangement and control of operation zones. Site organization is discussed in this section.

4.2 SITE ORGANIZATION-OPERATION ZONE

4.2.1 Exclusion Zone

An exclusion zone will be established on the site around drilling and soil sampling locations. The Field Team Leader will establish the perimeters of the exclusion zone. Within the exclusion zone, prescribed levels of protection must be worn by all personnel.

4.2.2 Support Zone

The support zone is the outermost area of the site (including roads) and is considered a nonhazardous area. The support zone contains the command post for field operations. Normal work clothes are appropriate apparel within this zone. The support zone includes decontamination for level C operations as necessary.

4.3 SITE SECURITY

Site security will be enforced by the Site Health and Safety Officer, who will ensure that only authorized personnel are allowed in the work area and that entry personnel are trained under the requirements of 29 CFR 1910.120 as necessary, and are on a current medical monitoring program as necessary. Site security is necessary to prevent exposure of unauthorized individuals in the work area.

4.4 SITE COMMUNICATION

Internal site communication is necessary to alert field team members in the exclusion zone of emergency conditions, to convey safety information, and to communicate changes or clarification in the work to be performed. Communication will be performed via verbal exchange or simple hand signals to be determined by the Site Health and Safety Officer and established with field personnel at the initial site health and safety

briefing. Example hand-signals that may be used by Parsons ES personnel are in Table 4.1.

Table 4.1. Example Nonverbal Communications Signals.

Visual Signals	Example	Interpretation
Hand signals	Hand clutching throat	Out of air/can't breathe
	Hand moving across throat	Stop action, such as hit the kill switch on drill rig
	Fist in the air	Stop vehicle
Whole body movements	Hands on top of head	Need assistance
	Thumbs up	OK/I'm alright/I understand
	Thumbs down	No/negative
	Grip partner's waist or both hands around partners waist	Leave area immediately

4.5 SAFE WORK PRACTICES

To ensure a strong safety awareness program during field activities, personnel must have adequate training, this health and safety plan must be communicated to the employees, and standing work orders must be developed and communicated to the employees.

4.6 ACCIDENT PREVENTION

All field personnel will receive health and safety training prior to the initiation of any site activities. On a day-to-day basis, individual personnel should be constantly alert for indicators of potentially hazardous situations and for signs and symptoms in themselves and others that warn of hazardous conditions and exposures. Rapid recognition of dangerous situations can avert an emergency. Before beginning daily work assignments, the team leader will conduct a meeting to discuss at a minimum the following:

- Tasks to be performed
- Time constraints (e.g., rest breaks)
- Hazards that may be encountered, including their effects, how to recognize symptoms or monitor them, concentration limits, or other danger signals
- Emergency procedures.

Tailgate health and safety meetings will be held daily and recorded in the log book.

4.7 CONTINGENCY PLAN

4.7.1 Emergency Procedures

In the event that an emergency develops on site, the procedures delineated herein are to be immediately followed. Emergency conditions are considered to exist if:

- Any member of the field crew is involved in an accident or experiences any adverse effects or symptoms of exposure while on site,
- A condition is discovered that suggests the existence of a situation more hazardous than anticipated,
- A UXO hazard is suspected,
- A fire or explosion hazard exists,
- Physical injury and medical emergencies have occurred, or
- A vehicle accident occurs.

Some ways of preventing emergency situations are listed below:

- Visual contact must be maintained between all crew members;
- Hand signals will be developed for communications;
- All field crew members should make use of all their senses to alert themselves to potentially dangerous situations which they should avoid;
- Field crew members will be familiar with the physical characteristics of the area, such as accessibility to associates, equipment, and vehicles; site access; nearest water source; nearest telephone; wind direction in relation to contamination zones; etc.;

Prior to beginning work at each SWMU, the Site Health and Safety Officer will review the site egress in case of emergency. Unless otherwise noted by the Site Health and Safety Officer, the field crew will exit the site in an emergency in the same manner as the entrance to the site.

General emergency procedures and specific procedures for personal injury and chemical exposure are described below.

4.7.2 Chemical Exposure

Parsons ES adopts the buddy system in the field. If a member of the field crew demonstrates symptoms of chemical exposure, the procedures outlined below will be followed:

- Another team member will remove the individual from the immediate area of contamination. The member will alert the Field Team Leader by shouting or hand signals. The Field Team Leader will contact the appropriate emergency response agency.
- Precautions will be taken to avoid exposure of other individuals to the chemical.

- If the chemical is on the individual's clothing, the chemical will be neutralized or removed if it is safe to do so.
- If the chemical has contacted the skin, the skin will be washed with copious amounts of water.
- In case of eye contact, an emergency eyewash will be used. Eyes will be washed for at least 15 minutes.
- If necessary, the victim will then be transported to the Methodist Hospital located at 7700 Floyd Curl in northwest San Antonio (see map in front section of safety plan). If necessary, an Army ambulance will be called at (512) 221-7408 to transport the victim.
- All chemical exposure incidents must be reported to the office health and safety representative. The initial report must be followed up with a written report. The Site Health and Safety Officer or Field Team Leader is responsible for completing the accident report (see Appendix A).

4.7.3 Personal Injury

In case of personal injury at the site, the following procedures will be followed:

- Another team member will signal the Field Team Leader that an injury has occurred.
- A field team member trained in first aid can administer treatment to an injured worker. The Field Team Leader (or designee) will contact the appropriate emergency response agency.
- The victim will then be transported to the Methodist Hospital located at 7700 Floyd Curl (see map in front section of safety plan). If necessary, an Army ambulance will be called at (512) 221-7408 to transport the victim.
- The Site Health and Safety Officer will report the accident to the office health and safety officer.
- The Field Team Leader or Site Health and Safety Officer is responsible for making certain that an accident report form is completed (Appendix A). This form is to be submitted to the office health and safety representative. Follow-up action will be taken to correct the situation that caused the accident.

4.7.4 Evacuation Procedures

If site evacuation is necessary:

- The Field Team Leader will initiate the evacuation procedure by signaling the team. The Field Team Leader (or designee) will contact the appropriate emergency response agency.
- All personnel in the work area will evacuate the area and meet in the common area designated during the first on-site health and safety meeting.

- All personnel suspected to be in or near the contract work area will be accounted for and the whereabouts of missing persons determined immediately.
- Further instructions will then be given by the Field Team Leader.

4.7.5 Procedures Implemented in the Event of a Major Fire, Explosion, or On-site Health Emergency Crisis

- The Field Team Leader or Site Health and Safety Officer (or designee) will notify the paramedics and/or fire department, as necessary.
- All personnel will evacuate the area.
- All personnel will stay upwind of any fire.
- The Field Team Leader or Site Health and Safety Officer will keep area surrounding the problem source clear after the incident occurs.
- The Site Health and Safety Officer will report the incident to the office health and safety officer, complete accident report form, and distribute to appropriate personnel.

In addition, CSSA fire prevention and protection procedures (Fort Sam Houston 420-5) must be observed. This regulation is presented in Appendix C.

SECTION 5

REFERENCES

CSSA, 1984. Memorandum regarding hazardous waste inspection conducted by Mr. Higgins, Solid Waste Management Program, Texas Department of Health, May 3, 1984.

CSSA, 1991. Memorandum regarding substances and/or material previously held in temporary hazardous waste area, December 11, 1991.

CSSA, 1992. History fact sheet, evaporation pond. Camp Stanley Storage Activity, March 17, 1992.

ES, 1993. Environmental Assessment for Camp Stanley Storage Activity. Parsons Engineering Science, Inc., Austin, Texas, September 1993.

Hill, 1987. Emergency Medical Procedures for the Home, Auto, and Workplace, revision edition. The Deltakron Institute, New York: Prentice-Hall Press, 1987. Patricia B. Hill, Editor.

OSHA Title 29 CFR 1910 and 1926.

RRAD, 1985. Letter from Addington to Commander, CSSA regarding closure plan for holding pond. August 2, 1985.

US Army, 1971. Environmental Health Engineering Department, Fifth US Army Medical Laboratory, Report of Engineering Survey-Industrial Waste and Wastewater Treatment Plant, Camp Stanley Storage Activity, October, 1971.

PLAN ACCEPTANCE FORM

SUMMARY OF ACTIVITIES

Activities to be performed at CSSA under this health and safety plan consist of site mapping, geophysical surveys, drilling, well installation, and sampling of soil, rock, and water at twenty-eight CSSA SWMUs. All work will be performed in level D or level C at the oxidation pond or other high priority SWMUs, as defined by this plan.

ACCEPTANCE

I have read the health and safety plan for the field activities listed above at Camp Stanley Storage Activity and agree to abide by the rules and guidelines contained therein.

Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date
Name	Signature	Date

Original signatures will be filed in the Parsons Engineering Science contract file, 728487.01000. Copies will be retained by the Project Manager.

ADDENDUM
HEALTH AND SAFETY PLAN FOR
TREATABILITY STUDY FIELD DEMONSTRATION(S)

1.0 INTRODUCTION

This addendum modifies the existing Health and Safety Plan for the Closure of Solid Waste Management Units (SWMUs) (Parsons ES, 1995). This Health and Safety Plan was prepared to address specific upcoming field tasks at Camp Stanley Storage Activity (CSSA), in Boerne, Texas.

Included in this addendum are site-specific descriptions and proposed activities; hazard evaluation; personal protective equipment (PPE); air monitoring; site control procedures; employee exposure monitoring; and emergency response procedures.

2.0 SITE-SPECIFIC DESCRIPTION AND PROJECT ACTIVITIES

During this effort, field work will take place at several solid waste management units (SWMUs) at CSSA. This fieldwork will be conducted from approximately early March 2001 through September 2002. During previous investigations, fieldwork was conducted at the B-20 former open burn/open detonation (OB/OD) area. During this investigation, field work will also be conducted at the demolition dud area, and SWMUs B-24, B-28 and B-8. Each of these units and the activities to be conducted there are described below. In general, the field work will consist of field demonstration(s) of potential remedial technologies.

2.1 B-8 Former Trench and Fill Area

The B-8 former trench and fill area is located in the north pasture, and occupies approximately one acre. This site was identified in the field during the 1993 environmental assessment (ES, 1993). Metal, small ammunition, and metal ammunition parts were observed there. Investigations conducted at the site in 1994 and 1995 included a geophysical survey and drilling and sampling of soil borings. The geophysical survey indicated that there is one isolated anomaly at the site. This anomaly was found east of the burn area and may be associated with buried metal debris. This anomaly is thought to consist of waste scrap metal and possibly minor amounts of UXO mixed in a soil matrix. This material will be excavated and sifted to remove the UXO and metal scrap to the greatest extent possible. In addition, a trailer-mounted electromagnet will be pulled over the excavated material to remove scrap metal.

2.2 B-20 Former OB/OD Area

The B-20 former OB/OD area is described in detail in the Health and Safety Plan for Remedial Investigation at the B-20 Site (Parsons ES, 1994). The primary objectives for work efforts at the B-20 site are removal of lead-contaminated soils (in the ammunition disposal areas), UXO, and scrap metal. Removal of lead-contaminated soils will be accomplished by excavation, stabilization, and off-site disposal. UXO and scrap metal will be removed by sifting the soil. The top 6 inches of surface soils in the northern 5-acre area of the site, where the majority of buried UXO and metal has been identified during previous investigations, will be sifted. A trailer-mounted electromagnet will be pulled over the excavated material to remove scrap metal.

2.3 Demolition Dud Area

The demolition dud area consists of approximately 3.5 acres in the inner cantonment area of CSSA, and was first identified during the 1993 environmental assessment (ES, 1993). Prior uses of the site are unknown; however, the area is posted with "Demolition Dud Area" warning signs. Investigation of the site commenced with a sweep for surface UXO. During this work, a disposal trench measuring 250 feet long and estimated to be about 2 feet deep was identified. A number of UXO items have been identified, primarily including fuses and Stokes mortars. The trench consists of waste scrap metal and possibly UXO mixed in a soil matrix. This material will be excavated and sifted to remove the UXO and metal scrap. In addition, a trailer-mounted electromagnet will be pulled over the excavated material to remove scrap metal.

2.4 B-24 Disposal Area

The B-24 site covers approximately 5 acres in the north pasture of CSSA. This site was identified in the field during the 1993 environmental assessment (ES, 1993). Spent ammunition and small spent rockets were observed there. A geophysical survey was conducted at the site in 1995. Three isolated anomalies were identified at the site. Preliminary UXO work done at the site this year indicates that four trenches were used to dispose of waste material consisting primarily of rifle cartridges. A small number of 20 mm projectiles (UXO) have also been identified at the site. Each trench is estimated to be approximately 15 feet deep. Each trench consists of waste scrap metal and a minor amounts of UXO mixed in a soil matrix. This material will be excavated and sifted to remove the UXO and metal scrap to the greatest extent possible. In addition, a trailer-mounted electromagnet will be pulled over the excavated material to remove scrap metal. However, small brass bullet casings in the waste material will be difficult to remove because they are non-ferrous material. The brass casings will be removed to the greatest extent possible by sifting and manual separation.

2.5 B-28 Disposal Area

The B-28 site covers less than one acre in the inner cantonment of CSSA. This site was identified in the field during the 1993 environmental assessment (ES, 1993). Molten metal, small ammunition, and metal ammunition parts were observed there. Investigations conducted at the site in 1994 and 1995 included a geophysical survey, a soil gas survey, and drilling and sampling of soil borings. The geophysical survey

indicated that there are two northwest-southeast trending trenches containing buried metal. The northern trench is approximately 300 feet long and 15 feet wide. The southern trench is approximately 100 feet long and 15 feet wide. The trenches are apparently shallow (less than 3 feet deep) as evidenced by field observations where the northern trench intersects the drainage ditch. Each trench consists of waste scrap metal and a minor amounts of UXO mixed in a soil matrix. This material will be excavated and sifted to remove the UXO and metal scrap to the greatest extent possible. In addition, a trailer-mounted electromagnet will be pulled over the excavated material to remove scrap metal.

3.0 HAZARD EVALUATION

3.1 Chemical Hazards

General hazards are addressed in the health and safety plan for remedial investigation of the B-20 site. Specific hazards associated with the trenching and sifting activities are identified below.

The major chemical known or suspected to occur at the sites listed above is lead. Previous sampling results indicate that only lead occurs at levels exceeding industrial site soil-air ingestion standards (30 TAC 335 Subchapter S). Other chemicals potentially occurring include copper, mercury, zinc, and 2,6-DNT. Health hazard qualities for 2,6-DNT are presented in Section 2 of the B-20 Health and Safety Plan (Parsons ES, 1994). Toxicologic properties of the metals are listed in the following table.

Toxicologic Properties of Compounds

Compound	PEL (mg/m^3)	TLV (mg/m^3)	IDLH (mg/m^3)	Odor Threshold (ppm)	Physical Description/Health Effects/Symptoms
Copper (dust/mists)	1	1	100	NA	Reddish, lustrous, malleable, and odorless, solid metal. Irritates eyes, nose, skin, and pharynx. Causes a metallic taste, nasal perforation, nausea, vomiting, and dermatitis. In animals, causes anemia and lung, liver, and kidney damage. Experimental teratogen, questionable carcinogen.
Lead	0.05	0.15	100	NA	Heavy, ductile, bluish-gray, soft metal. Irritates eyes. Causes weakness, exhaustion, insomnia, facial pallor, anorexia, low-weight, malnutrition, constipation, abdominal pain, gastritis, colic, gingival lead line, anemia, wrist and ankle paralysis, joint tremors, low blood pressure, and kidney disease. Mutagen, experimental teratogen, suspected carcinogen.

Compound	PEL (mg/m^3)	TLV (mg/m^3)	IDLH (mg/m^3)	Odor Threshold (ppm)	Physical Description/Health Effects/Symptoms
Mercury (aryl, inorganic, vapors)	0.1 (ceiling) 0.05 (vapor)	0.1 (skin) 0.025 (inorg)	10	NA	Silver-white, heavy, odorless, liquid or tin-ductile, malleable, soft, solid metal. Corrosive to skin, eyes, and mucous membranes. Causes dermatitis, coughing, chest pain, shortness of breath, bronchitis, lung inflammation, ringing in the ears, tremors, insomnia, irritability, indecision, headaches, fatigue, weakness, fever, salivation, inflammatory disease of the mouth, gastrointestinal disturbances, anorexia, low-weight, and protein in the urine. Mutagen, experimental teratogen, questionable carcinogen.
Zinc (based on zinc oxide)	5 (fume, respirable fraction) 10 (dust)	5 (fume) 10 (dust)	500	NA	Fine, white or yellowish, odorless particulate. Irritates respiratory system. Causes metallic taste, cough, chills, fever, tight chest, headaches, rales, blurred vision, muscle aches, nausea, vomiting, dry throat, weakness, lower back pain, exhaustion, fatigue, vague discomfort, shortness of breath, and decreased pulmonary function. Fumes cause metal fume fever. Mutagen, experimental teratogen.

3.2 Physical Hazards

Potential physical hazards at these sites include risks associated with UXO, sifting, trenching, underground utilities; heavy equipment; motorized vehicles; slip, trip, and fall hazards; noise; dust, and heat stress.

Protection standards for physical hazards are contained in Section 3 of the Health and Safety Plan (Parsons ES, 1995). Topics not discussed in that document are addressed below.

3.2.1 Mixing operations

Soils containing metal debris from excavation, sifting and stockpiling operations from the B-20 site will be mixed with Appatite II material. The stockpiled soils will be loaded into the mixer's hopper by a front-end loader. Once the material has been mixed the treated soils will be taken and placed within a designated area.

Caution will be taken when working around the earth-moving equipment. Hand signals will be established before any field work commences.

3.2.2 Trenching

Before excavation activities are initiated, the estimated location of all underground utilities will be determined in coordination with CSSA personnel. Excavations at all

locations are expected to reach a maximum depth of five feet or less. Trenches greater than 4 feet deep will not be entered without a confined space permit.

US Occupational Safety and Health Administration (OSHA) excavation, trenching, and shoring standards will be followed in accordance with 29 Code of Federal Regulations (CFR) 1926, Subpart P. Excavations greater than 4 feet in depth will be sloped at least 34 degrees, which is considered safe by OSHA for any type of soil classification. Daily inspections of excavations, the adjacent areas, and any protective systems will be made by a competent person representing Parsons ES for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. Such inspections will be conducted prior to the start of work and as needed throughout the day's activities. Inspections also will be made after every rainstorm or other occurrence that might increase hazards. If indications are observed of possible cave-in of the excavation or failure of the protective system, then the protective system will be redesigned, if necessary, and proper construction or assembly of the protective system will be confirmed before work continues at that excavation. If hazardous conditions are suspected, appropriate steps will be taken as necessary to minimize such hazards before work is continued.

3.2.3 Heat Stress

Adverse weather conditions are important considerations in planning and conducting site operations. Hot or cold weather can cause physical discomfort, loss of efficiency, and personal injury. Of particular importance is heat stress resulting when protective clothing decreases natural body ventilation. Heat stress can occur even when temperatures are moderate if employees are wearing impermeable protective clothing. One or more of the following recommendations will help reduce heat stress:

- Provide plenty of liquids to replace body fluids. Water and/or commercial electrolyte mixes should be available on site.
- Provide cooling devices to aid in natural body ventilation. These devices, however, add weight, and their use should be balanced against worker efficiency.
- Wear cotton long underwear, which acts as a wick to help absorb moisture and protect the skin from direct contact with heat-absorbing protective clothing.
- Install mobile showers and/or hose-down facilities to reduce body temperature and cool protective clothing.
- In extremely hot weather, conduct non-emergency response operations in the early morning or evening.
- Ensure that adequate shelter is available to protect personnel against heat, sun, or other adverse weather conditions which decrease physical efficiency and increase the probability of accidents.
- In hot weather, rotate workers wearing protective clothing.
- Maintain good hygienic standards, frequently changing clothing and daily showering. Clothing should be permitted to dry during rest periods. Workers

who notice skin problems should immediately inform the Site Health and Safety Officer who will in turn consult medical personnel.

Effects of Heat Stress

If the body's physiological processes fail to maintain a normal body temperature because of excessive heat, a number of physical reactions can occur. They can range from mild symptoms such as fatigue, irritability, anxiety, and decreased concentration, dexterity, or movement, to death. The location of a first-aid manual detailing specific first-aid treatment for mild cases of heat stress should be known at all times by the Site Health and Safety Officer for reference in the field. Medical help must be obtained for the more serious cases of heat stress.

Heat-Related Problems

- **Heat rash:** Cause by continuous exposure to heat and humid air and aggravated by chafing clothes. Decreases ability to tolerate heat and is a nuisance.
- **Heat cramps:** Cause by profuse perspiration with inadequate fluid intake and chemical replacement, especially salts. Signs include muscle spasms and pain in the extremities and abdomen.
- **Heat exhaustion:** Caused by increased stress on various organs to meet increased demands to cool the body. Signs include shortness of breath; increased pulse rate (120-200 beats per minute); pale, cool, moist skin; profuse sweating; and dizziness and lassitude.
- **Heat stroke:** The most severe form of heat stress. Body must be cooled immediately to prevent severe injury and/or death. Signs include red, hot, dry skin; no perspiration; nausea; dizziness and confusion; strong, rapid pulse, and possibly coma. Medical help must be obtained immediately.

Heat-Stress Monitoring

Monitoring of personnel wearing impervious clothing may begin when the ambient temperature is 70°F or above. Monitoring of heat stress for other working conditions will occur at the worker's request, at the discretion of the Site Health and Safety Officer, or as conditions change. The following table presents the suggested frequency for such monitoring. Monitoring frequency will increase as ambient temperature increases or as slow recovery rates are observed. Heat-stress monitoring will be performed by a person with a current first-aid certification who is trained to recognize heat-stress symptoms. For monitoring the body's recuperative abilities from excess heat, one or more of the techniques listed below will be used. Other methods for determining heat-stress monitoring, such as the wet bulb globe from the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) Booklet, may be used.

Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers[1]

Temperature	Normal Work Ensemble	Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5-90°F (30.8-32.2°C) or above	After each 60 minutes of work	After each 30 minutes of work
82.5-87.5°F (28.1-30.8°C) or above	After each 90 minutes of work	After each 60 minutes of work
77.5-82.5°F (25.3-28.1°C) or above	After each 120 minutes of work	After each 90 minutes of work
72.5-77.5°F (22.5-25.3°C) or above	After each 150 minutes of work	After each 120 minutes of work

1 For moderate work, e.g. walking about with moderate lifting and pushing.
2 A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.

To monitor the worker, measure:

- **Heart rate:** Count the radial pulse during a 30-second period as early as possible during the rest period.
  - ➪ If the heart rate exceeds 110 beats per minute at the beginning of the rest period, the next work cycle will be shortened by one-third and the rest period will remain the same.
  - ➪ If the heart rate still exceeds 110 beats per minute at the next rest period, the following work cycle will be reduced by one-third.
- **Oral temperature:** Use a clinical thermometer (3 minutes under the tongue) or similar device to measure the oral temperature at the end of the work period (before drinking).
  - ➪ If oral temperature exceeds 99.6°F (37.6°C), the next work cycle will be reduced by one-third without changing the rest period.
  - ➪ If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, the following cycle will be reduced by one-third.
  - ➪ No worker will be permitted to wear a semipermeable or impermeable garment when oral temperature exceeds 100.6°F (38.1°C).

4.0 AIR MONITORING

Soil samples collected and analyzed in the B-20 area recently show an elevated level of lead in the clay soil matrix. The highest concentration measured in this area is 2,400 mg/kg. Preliminary samples have been collected at B-24 and B-28; however, analytical data are not yet available. Based on the nature of waste disposal at these sites (including the demolition dud area), lead is the primary contaminant of concern. Sand which contains lead bullet shot will be excavated in three areas (B-31, B-32 and B-33) which also have a potential for possible elevated lead levels. Since the lead is in a solid form, lead dust levels should not be a concern. Nevertheless, dust levels will be suppressed with engineering controls such as spraying water on the surface soils and excavated soils were the dust is being generated. If particulate levels still persist, dust masks or respirators with HEPA cartridges will be donned and particulate levels will be monitored. A real-time air/dust monitor (Miniram) may be used to monitor particulates in the field teams breathing zone, during soil excavation and soil sifting operations if high levels of

particulate are observed and continue to exist after being suppressed. The Miniram can only measure total dust particulates that are airborne, and cannot measure potential ambient lead.

5.0 SITE CONTROL PROCEDURES

Site control measures will be followed to minimize potential contamination of workers, protect the public from potential site hazards, and control access to the sites. Site control involves the physical arrangement and control of the operation zones and the methods for removing contaminants from workers and equipment. Section 4 of the Health and Safety Plan includes a description of the site control procedures.

Specific site control procedures at these site will include establishment of site work zones whenever sifting or trenching activities are underway, or if any trenches are open. All open excavations will be barricaded until backfilled, and unauthorized personnel will be restricted from entering the immediate work area.

6.0 PERSONAL PROTECTIVE EQUIPMENT

It is anticipated that all work will be conducted in Level D respiratory protection, with a contingency provision for use of dust masks or respirators. Additional guidelines for the selection of respiratory protection at these sites are contingent upon the discovery of elevated lead particulates in the worker breathing zone while performing site activities. Site crews will assess the need for respiratory protection, or PPE, as applicable with a Miniram. In addition, engineering controls such as spraying water in areas where dust is being generated will be incorporated.

Protective clothing to be used at these sites includes:

- Hard hats
- Safety glasses
- Dust mask
- Respirator, if needed (HEPA cartridges)
- Outer gloves (Leather)
- Boots (Safety boots)
- Proper hearing protection

7.0 EMPLOYEE EXPOSURE MONITORING

Employee exposure monitoring will be conducted on this site in accordance with OSHA standards (29 CFR 1910) and the B-20 Health and Safety Plan.

8.0 EMERGENCY RESPONSE PLAN

8.1 Safe Distances and Places of Refuge

Prior to initiation of field activities, the field crew shall decide on safe distances to retreat to and select a place of refuge in the event of an emergency. This information shall be provided to all field personnel during daily site-specific safety briefings. All

other guidelines established in the Health and Safety Plan for emergency planning, training, and recognition shall be followed.

8.2 Emergency Information

Listed below are the names and telephone numbers for medical and emergency services for this project.

Hospital	Methodist Hospital
Address	7700 Floyd Curl Rd. San Antonio, TX
Phone	(210) 692-4444

Description of the route to the hospital:

Hospital is located on the corner of Medical and Floyd Curl Drive. The route from the Camp Stanley main gate is south on Ralph Fair Road about 0.75 mile, south on Interstate 10 about 12.5 miles, exit on Wurzbach Road, take access road to Medical Drive, west on Medical Drive about 0.5 mile, and south on Floyd Curl Drive to hospital.

Other Emergency Numbers:

Fire Department	911
Security Police	911
Ambulance	911

Project Manager:

Ken Rice work: (512) 719-6050

Distribution:

William Bostick, MCL, Inc.

SangJin Choi, BATU EnviroTek, Seoul, South Korea

James DiClementi, Parsons, Inc., Fairfax, VA

Scott Dockum - SERDP/ESTCP Support Office

Teresa DuPriest, HQ AFCEE/ERD

Carlos Garcia, LANL SERDP/ESTCP Program Manager

William Goldberg, MSE Technology Applications, Inc.

Bryony Hanson, Golder Associates

Robert Hinchee, Battelle Memorial Institute

Craig Jones, Brice, Inc.

Greg Lyssy, U.S. EPA, Region VI

Ross Miller, Parsons, Inc.

Lena Ma, Florida State University

Annie Morin, TechnoRem, Montreal, Canada

Tim Moody, Metals Treatment Technology

Brian K. Murphy, Environmental Officer, Camp Stanley Storage Activity, TX

Mark Peterson, Parsons, Inc. Honolulu, HI

Sonny Rayos, TCEQ - Austin, TX

Ken Rice, Project Manager, Parsons, Inc., Austin, TX

Michael Ruby, Exponent, Inc.

Luke Russel, Idaho DEQ

David Slater, Slater (UK) Limited, England, UK

Vincent Swadis, Applied Earth Sciences

Steve Testa, Testa Environmental

Tetsu Tokunaga, Lawrence Berkeley Laboratory

Mike Warminsky, AMEC